Fatigue Analysis of Crankshaft

Qingqian Wang [1, a], Xiang Yu [1, b], Jizhong Zhang [1, c] and Mei Zhao [2]

[1]College of Mechanical and Electronic Engineering, Qingdao University, Qingdao 266071, China

[2]School of Foreign Language Education, Qingdao University, Qingdao 266071, China

[a]939678618@qq.com, [b]813663298@qq.com, [c]zjzqdu@163.com

Abstract

As the extremely important part of the internal combustion air compressor, the crankshaft has an important influence on the whole machine performance. The load of the crankshaft is usually a high frequency of cyclic load. It is very easy to produce fatigue failure in the stress concentration place. So this paper has introduced the fatigue analysis of crankshaft. Firstly, extract the key node stress; Secondly, deal with the load spectrum; finally, the fatigue analysis is carried on and the more accurate life prediction of key nodes are obtained.

Keywords

Crankshaft; Fatigue failure; Fatigue analysis.

1. Introduction

As an important part of fatigue analysis, the finite element technology greatly expands the application fields of nSoft software. How to make a variety of software datas seamlessly connect seem to be very important. In this paper, with the aid of the powerful software interface of nSoft software, the ADAMS simulation file is imported in nSoft software to be put into fatigue analysis. Fatigue analysis needing ADAMS documents in nSoft software includes the time course load file, the stress information file and the modal file.

2. Destruction Trend and Risk Node Capture of the Crankshaft

In nsoft software, Von Mises Stress is selected as the calculating parameter to analyze the whole life so that 10 nodes whose cycle index is the lowest and break is the worst are got . It is shown in Figure 1.

	Node	Life (Repeats)	Damage
1	6161	1.058E8	9.45187E-9
2	6159	1.3155E8	7.60151E-9
3	5914	1.454E8	6.87781E-9
4	5916	1.4548E8	6.87389E-9
5	158	2.2615E8	4.42176E-9
6	6157	2.3958E8	4.17401E-9
7	6156	2.3976E8	4.17082E-9
8	6155	2.3988E8	4.1687E-9
9	5738	2.6581E8	3.76202E-9
10	5932	2.6939E8	3.71215E-9

Figure 1 Fatigue analysis results of the crankshaft

It can be seen that five nodes destroyed the worst include Node_6161, Node_6159, Node_5914, Node_5916 and Node_158.

The results of the fatigue got in nSoft software will be imported into ADAMS to obtain the whole life cloud of the crankshaft. It is shown in Figure 2.

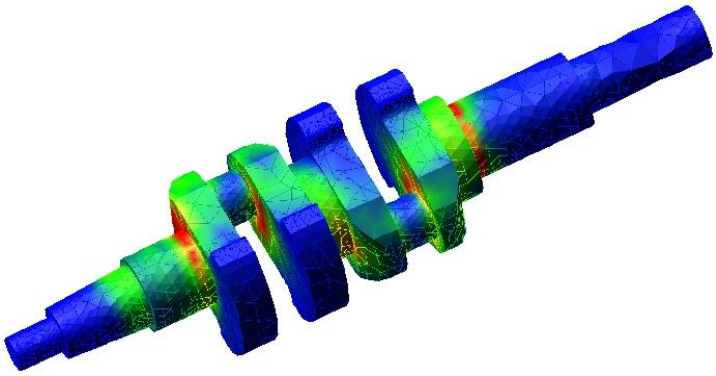

Figure 2 Life cloud figure of the crankshaft

Analysis results show that the cycle index is the least in Node _6161 place and the number is 1.058 E8. At the same time, it can be found the parts whose cycle index is smaller is mostly the place of the stress concentration, such as the place where the crankshaft root and the bearing contact. According to the results of the fatigue analysis, we can get the fatigue damage trend of the crankshaft. It also has certain reference significance to get the cycle index.

3. Fatigue Analysis of Key Nodes

Node _6161 is selected as the target node for the fatigue analysis of key nodes. As the load file data got in the ADAMS simulation is discrete and its confidence is low, for coinciding as much as possible with the actual target load of the crankshaft, it needs to be done that the original load is extrapolated. The first 100 point affected by the larger force is extracted in ADAMS. Here the first 12 nodes are intercepted. It is shown in Figure 3.

Top 100 Hot Spots			Radius= 1.5 mm			
Hot Spot	Stress	Node	Time	Location wrt LPRF (mm)		
#	(newton/mm**2)	id	(sec)	X	Y	Z
1	195.493	6161	0.00194444	-14.8677	27.7909	-171.787
2	193.319	6159	0.001875	-14.8677	27.1223	-180.325
3	189.412	5916	0.001875	-41.677	24.9485	-201
4	189.391	5914	0.001875	-41.7757	28.285	-201.148
5	187.241	158	0.001875	-11.8045	31.3555	-167.839
6	186.971	6157	0.00194444	-14.8677	27.1288	-189.435
7	186.616	6156	0.00194444	-14.8677	27.1288	-194.03
8	185.851	6155	0.001875	-14.8677	27.1288	-198.625
9	184.02	6059	0.00194444	-13.9175	18.3455	-203.49
10	182.788	5932	0.00194444	-28.8142	11.9254	-159.572
11	182.34	5738	0.001875	-32.8645	41.0019	-159.451
12	181.763	5948	0.001875	-23.1815	42.0175	-159.301

Figure 3 Larger stress nodes of the crankshaft

3.1 Extraction of Key Nodes Stress

Durability module in ADAMS can extract any node stress of the crankshaft. In the Flexible Body bar, Flexible Body of the crankshaft is choosen. In the Select Node List column, 6161 is filled in. The first

principal stress curve of the time course (5 cycles) of Node_6161 is shown in Figure 4. Through clicking DAC File of Export of File, time course load file output of Node_6161 is completed.

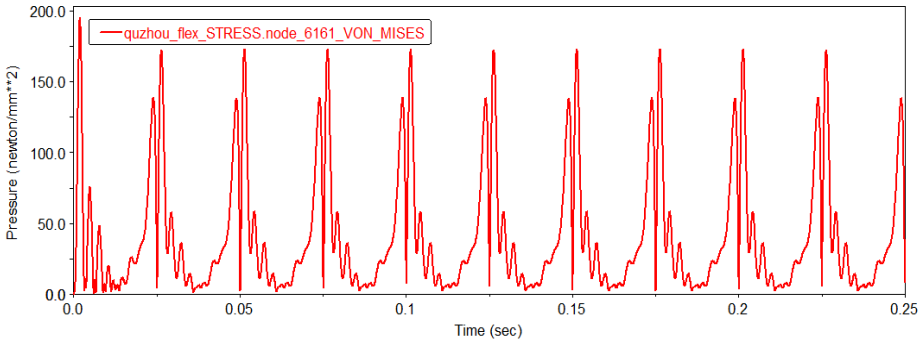

Figure 4 Stress curve of NODE_6161

3.2 Processing of Load Spectrum

In nSoft software, the extrapolation can be realized according to the laws of the curve itself, which can solve more samples and more time problem of the fatigue analysis in the field of statistics. Through the fatigue analysis of the curve load after the extrapolation, the fatigue analysis results of a high degree of confidence can be got.

Figure 5 is the rain flow histogram of the original load of Node _6161. Due to a very small sample size, it cannot satisfy the needs of more samples and more time of the fatigue analysis in nSoft software. So the original load extrapolation needs to be done. The rain flow histogram of the load after 100 times extrapolation is shown in Figure 6.

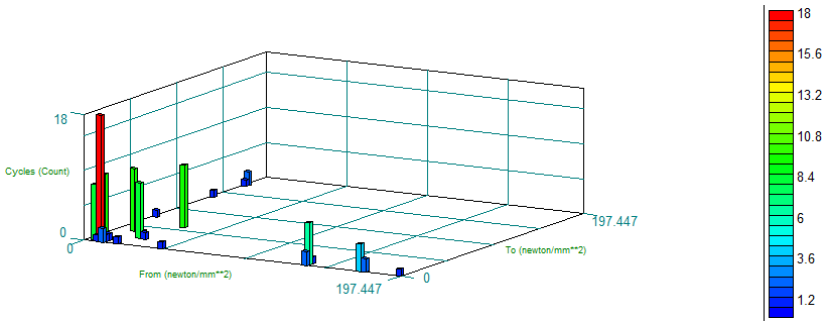

Figure 5 Rain flow histogram of the original load

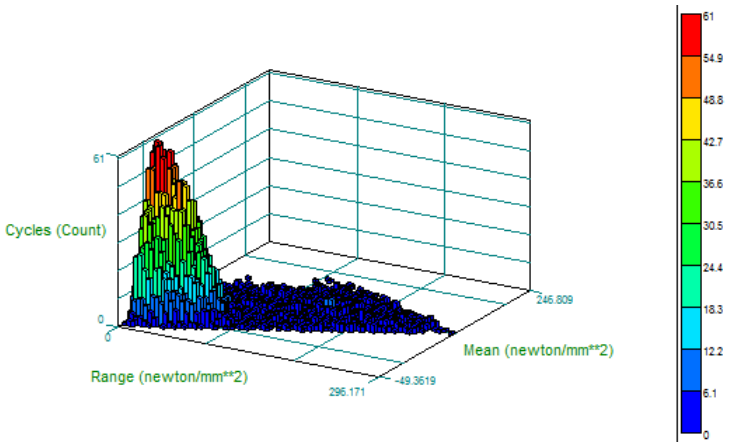

Figure 6 Rain flow histogram of the load after 100 times extrapolation

3.3 Fatigue Analysis and Life Prediction

After the rain flow histogram of the load after 100 times extrapolation is converted to the time course load file, the fatigue analysis is carried out on Node_6161. The analysis results are shown in Figure 7.

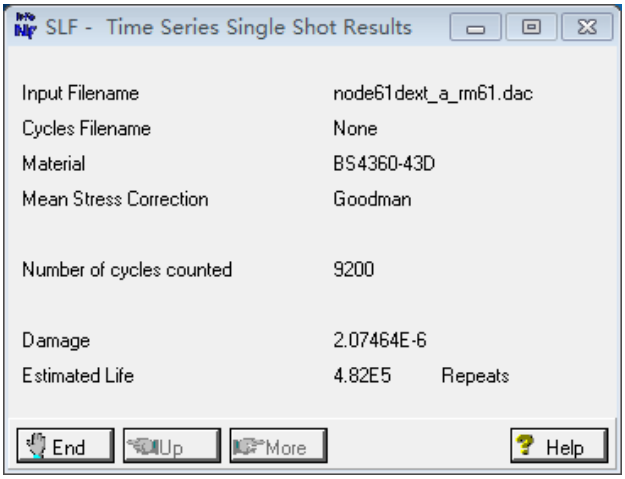

Figure 7 Fatigue analysis of Node_6161

According to using characteristics of internal combustion air compressor, the pneumatic machinery is used in urgent engineering repair and often cannot work continuously. It is realized that calculate the fatigue life which is 3347 hours after treatment of the Node_6161 node load.

4. Conclusion

In this paper, the fatigue analysis of the crankshaft is carried on based on nSoft software and ADAMS software so that the destruction trend of the crankshaft and the temporal information of key nodes are got. Through the fatigue analysis after the extrapolation of the load of the key nodes, the more accurate life prediction of key nodes is got.

Reference

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