

Vibrational Analysis of Mounting Base for a Winch

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Abstract. Mounting base will help to give better layout for equipment, and the vibrational performance is very important for vibration isolation design of equipment. The statics, modal and impedance analysis are conducted for mounting base of a winch in an experiment, the effect of gravity is also considered. Numerical results show that, the effect of gravity on modal frequency of mounting bases here is very small and could be ignored, the impedance is about 106 Ns/m, and it will change especially for amplitudes of resonance peaks with the change of location of external load force. Conclusions here will help to support the vibration isolation design for equipment.

Keyword: Mounting base; modal analysis; impedance.

1. Introductions

Mounting base not only give better layout for equipment, the vibrational performance is also very important for vibration isolation design of equipment. Therefore, it's very important to get clear the vibration performance of mounting base.

Many researchers have conducted work in this area. Nicgorski et.al.[1-2] establish the theoretical model for vibration isolation system of equipment under elastic foundation support, and the effect of base on modal performance and vibration isolation effect. Pingleton et.al.[3] point out that, input impedance of base is mainly affected by structural resonance in low frequency range, and the thickness of plated will be the major parameter with the increase of driven frequency. Leuridan and Grangier[4] studied the effect of parameters of elastic foundation for vibration response of total system. Duarte et.al. [5] applied the effective admittance method to analyze the impedance of different bases, and they also gave the prediction method for structural impedance in low and high frequency range. Ding et.al.[6] investigate the influence of different base type on vibro-acoustic performance of ships.

In this work, statics, modal and impedance analysis are conducted for mounting base of a winch in an experiment, and deformation, modal performance and impedance are studied.

2. numerical model

2.1 Model introduction

Mounting Base for a winch in an experiment is shown in Fig.1. The total length is 2.6m, the width is 2.4m. It's made up of a down plate of 22mm thickness and 8 small planes. Each 4 hole with diameter of 30mm are distributed uniformly at the down plate along the length direction, which could be applied to constraint the base. Small plane consist of surface plate of 32mm(the length is 200mm, the width is 160mm) and down frame of 18mm.

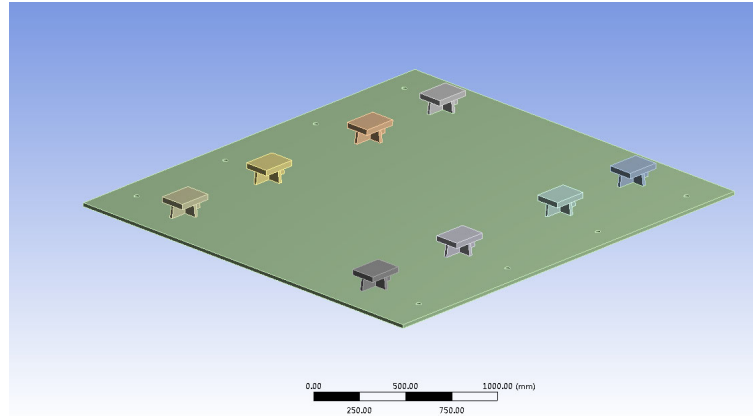


Fig. 1 Mounting base for a winch

2.2 Boundary condition and material

In this work, three load and boundary condition should be considered, the first is fixed support at 8 holes, the second is static force of 68000N at the surface of down plate, the third is the gravity acceleration, as is shown in Fig.2.

Structural steel is applied for mounting base, elastic module is 210GPa, the Poisson's ratio is 0.3, the density is 7850 kg/m³, gravity acceleration is 9.8066m/s².

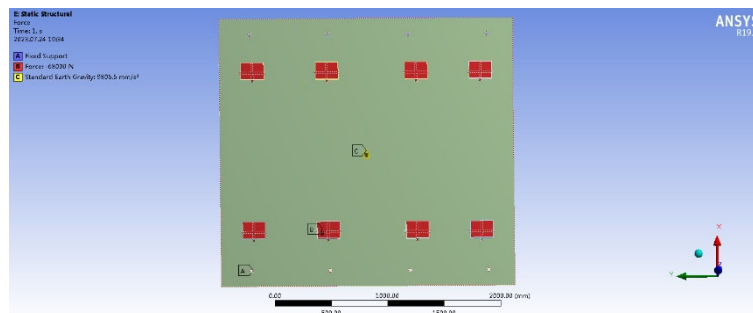


Fig. 2 external load and boundary conditions

2.3 Analysis process

Statics analysis. The deformation, stress and strain of mounting base is studied.

Modal analysis. Modal frequency and mode shape are considered, and the effect of gravity is also studied.

Harmonic analysis, forced vibrational response of mount base is obtained to calculate structural impedance.

3. Result analysis

3.1 Static analysis

Statics performance of mounting base is studied first, and the mass effect of equipment is considered by applying external load of 68000N, the results are shown in Fig.3-Fig.5.

Under gravity effect and external load of 68000N, the maximum deformation of mounting base is 0.38mm, and the location is at the middle of down plate; the strain is quite small, and the maximum is only 0.02%; the stress is also quite low, the maximum is 45MPa, the location is 8 holes.

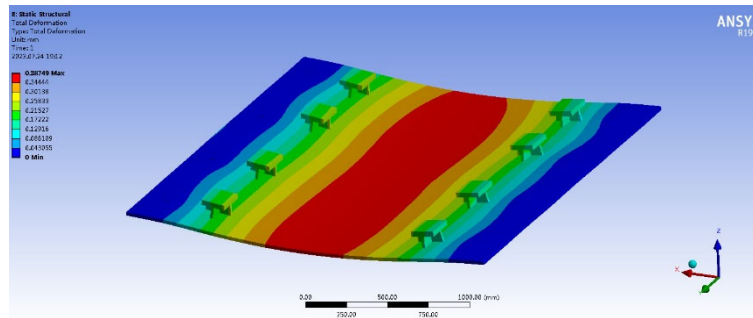


Fig. 3 Total deformation of mounting base

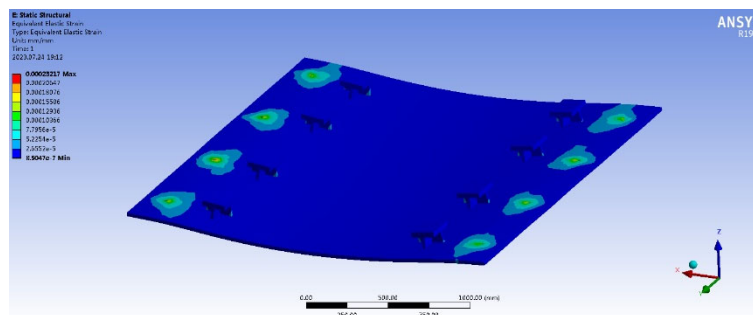


Fig. 4 Strain of mounting base

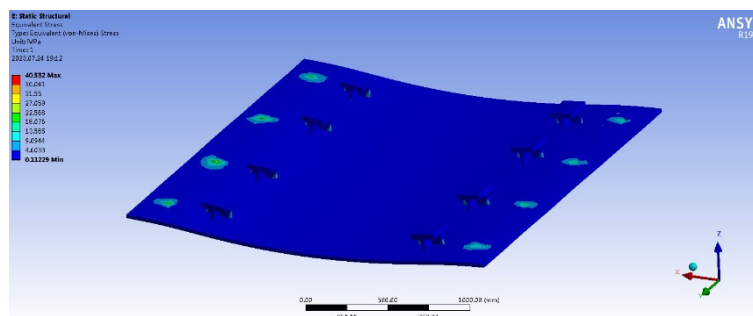


Fig. 5 Stress of mounting base

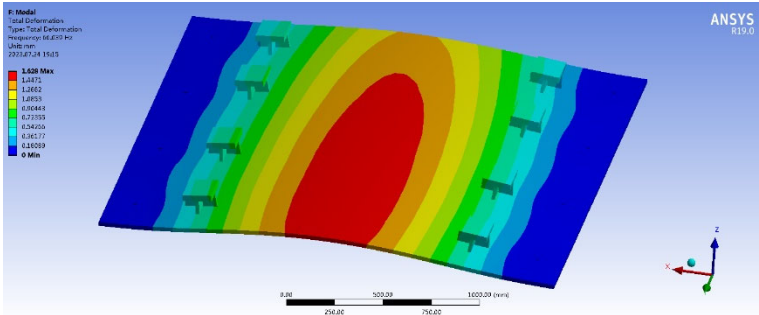
3.2 Modal analysis

Modal analysis is conducted for mounting base, the difference of modal frequency in cases of with and without gravity effect is also carried out. The first six modal frequencies are given in Table 1, and mode shapes are shown in Fig.6.

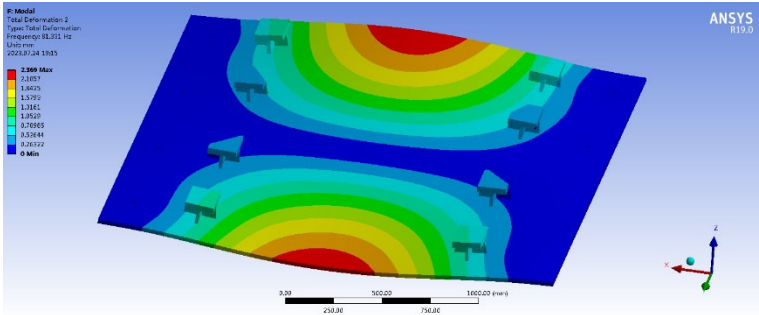
It's noted that the change of modal frequency of mounting base is very small in cases of with and without gravity effect, and it could be ignored. So the effect of gravity on modal performance of mounting base here could be neglected.

Table 1. the first six modal frequencies of mounting base

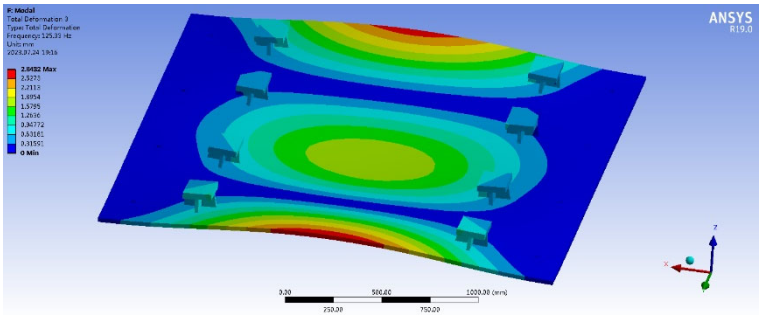
Mode order	With gravity	Without gravity
1	66.04	66.05
2	81.33	81.34
3	125.33	125.33
4	177.44	177.45
5	198.56	198.57
6	208.77	208.78



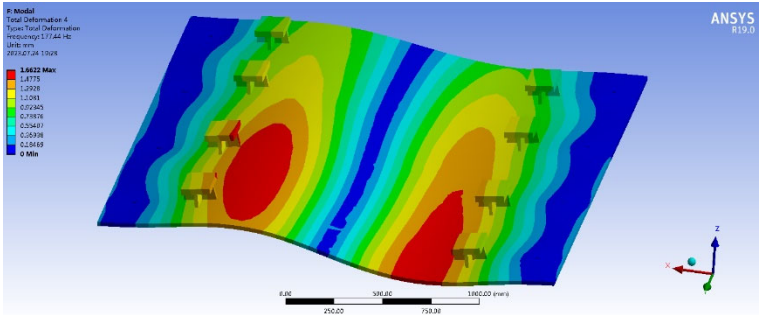
First mode



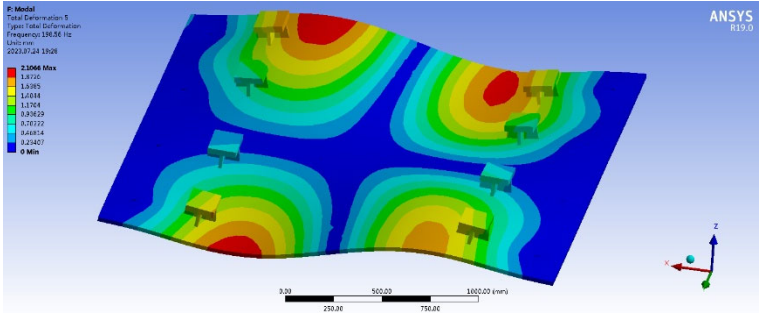
Second mode



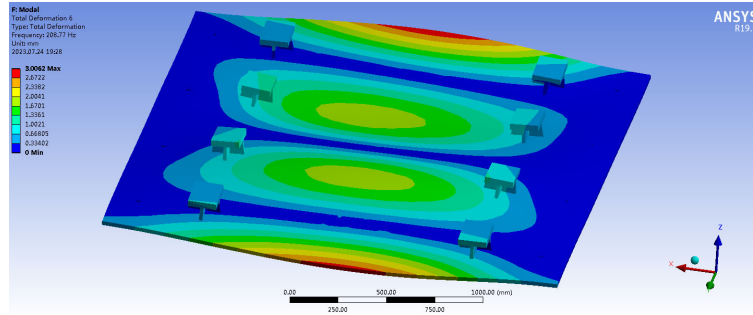
Third mode



Forth mode



Fifth mode



Sixth mode

Fig. 6 First six mode shapes for mounting base without gravity

3.3 Impedance analysis

The impedance of mounting base is also studied here. Average impedance is obtained by applying 1N external force. Impedance-1av and Impedance-2av represent average impedance of mounting base in case of force at plane 1 and 2 respectively, as is shown in Fig.7.

It's noted, the impedance for mounting base is about 10^6 Ns/m; in low frequency range, i.e., 10Hz-70Hz, the curve of structural impedance against frequency is nearly linear, and structural impedance increase with the increase of driven frequency, but is will flutter while $f > 70$ Hz; When the external force location changes, amplitude of peaks of impedance curve will change, but the location of main peaks in frequency range changes little.

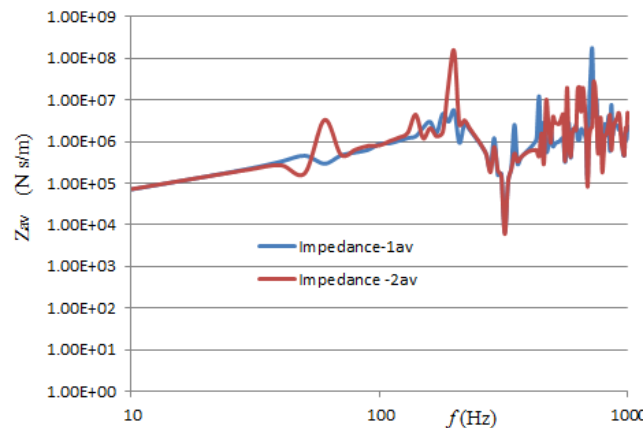


Fig. 7 impedance of mounting base

4. Conclusions

In this work, statics, modal and impedance analysis are conducted for mounting base of a winch in an experiment, the effect of gravity is also considered. Numerical results show that, the effect of gravity on modal frequency of mounting bases here is very small and could be ignored, the impedance is about 10^6 Ns/m, and it will change especially for amplitudes of resonance peaks with the change of location of external load force.

Acknowledgements

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