Harmonic Response Analysis of Groove Vibration Polishing Machine

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Abstract. The groove vibration polishing machine is made of Q235A. The allowable stress value is given by the yield limit. Its value is sigma s=235MPa.The harmonic response analysis of groove vibration polishing machine is to analyze the deformation and stress distribution of the tank body under different frequencies and excitation forces, so as to determine under which conditions the groove vibration polishing machine has the best vibration effect. The harmonic response analysis shows that, when the vibration frequency range is 0 ~ 25Hz and the exciting force is 50000N, the maximum stress is 31.88 Mp<[sigma] vibration polishing machine can meet the allowable stress requirement of materials. And the overall deformation of the tank is not large, so it meets the design requirements.

Keywords: vibration polishing machine; Frequency range; Harmonic response analysis.

1. Overview of Harmonic Response Analysis

Harmonic response analyst is a technique that used to determine the steady-state response of a linear structure under sinusoidal loads varying with time. The purpose of the analysis is to calculate the response of the structure at several frequencies, and to obtain the response value and the frequency change curve. This analysis technique only calculates the steady-state forced vibration of the structure, and the transient vibration occurring at the beginning of the excitation is not considered in the harmonic response analysis.

Like modal analysis, harmonic response analysis belongs to linear analysis, and any non-linear characteristics, even if defined in the analysis process, will be ignored. However, in the analysis, asymmetric matrices can be included, such as fluid-structure interaction. Harmonic response analysis can also be used to analyze structures with prestressing force.

2. Exciting Force Loading of Groove Vibration Polishing Machine

Harmonic response analysis assumes that the applied load varies with time according to the law of simple harmonic (sinusoidal), so to specify a complete simple harmonic load requires input amplitude (Amplitude, refers to the maximum load), phase angle (refers to the measure of load lag or lead and reference time), and forcing frequency range (refers to the frequency range of simple harmonic load). The vibration motor is mounted on the motor base on the left and right sides of the box body, and two vibration motors are also mounted on the bottom of the box body. Fig. 1 shows the position where the excitation force is applied to the slot vibration polishing machine.

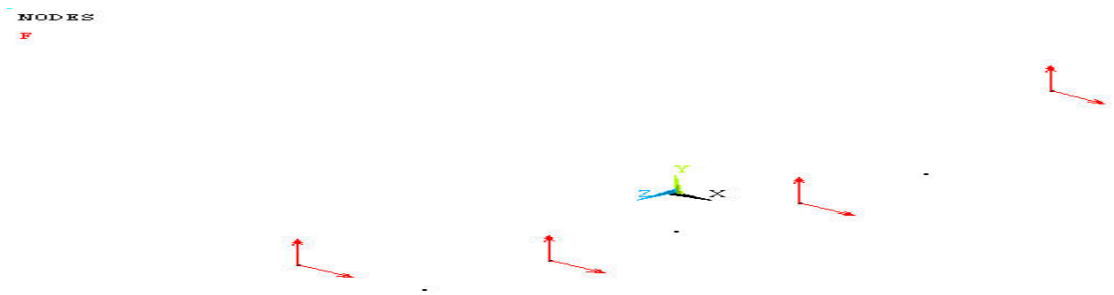


Fig 1. Loading

3. Harmonic Response Analysis of Groove Vibration Polishing Machine

By analyzing the deformation and stress distribution of the groove body at different frequencies and exciting forces, it is determined under which conditions the vibration effect of the groove vibration polishing machine is the best. The present design scheme is as follows:

Table 1. Design Scheme

Scheme	Frequency Range(Hz)	Load(F)
1	0~25	50000
2	0~25	60000
3	0~50	60000

3.1 Analysis Results of Slot Vibration Polishing Machine with Frequency Ranging from 0 Hz to 25 Hz and Load of 50000N

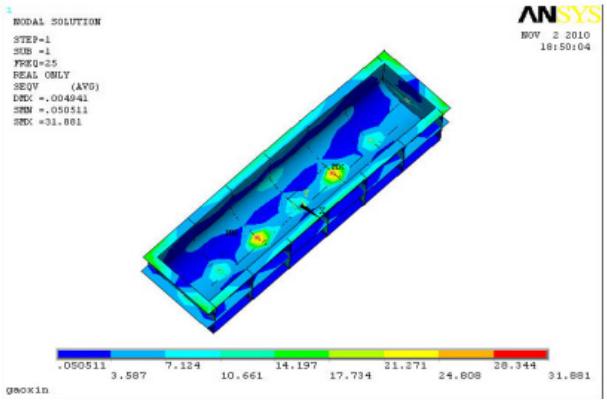


Fig 2. Deformation nephogram in Y direction

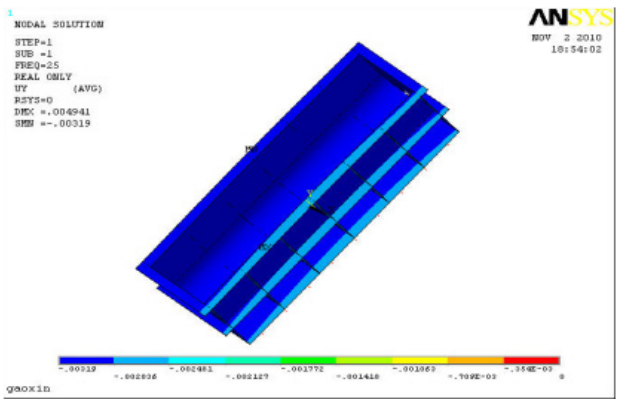
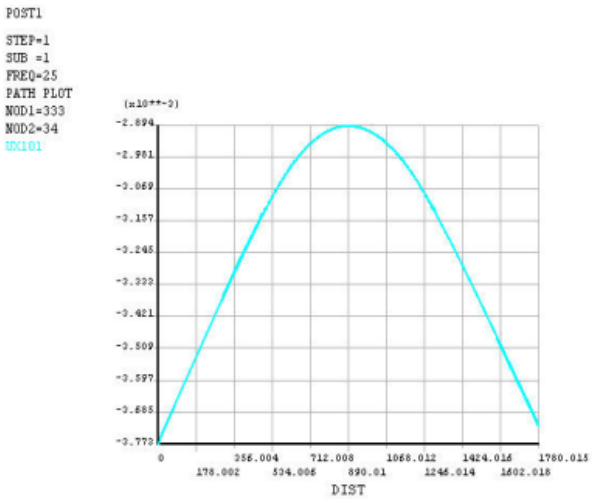
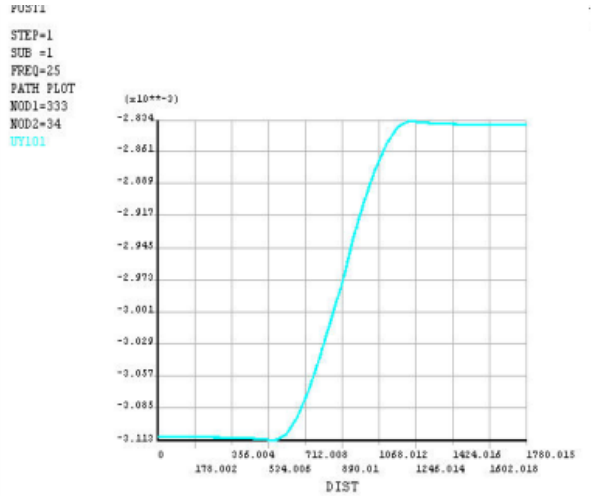


Fig 3. Equivalent stress nephogram

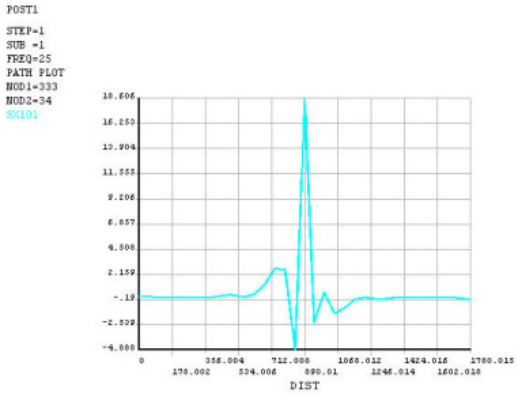


X direction displacement harmonic response curve

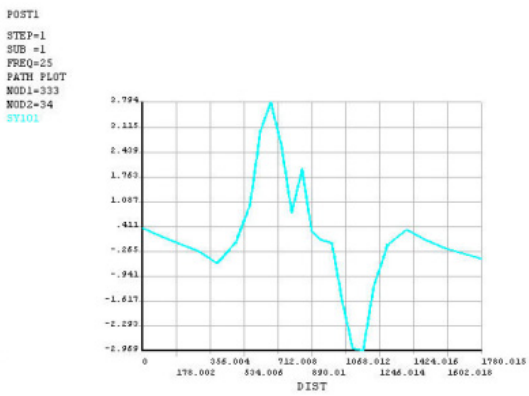


Y direction displacement harmonic response curve

(a)

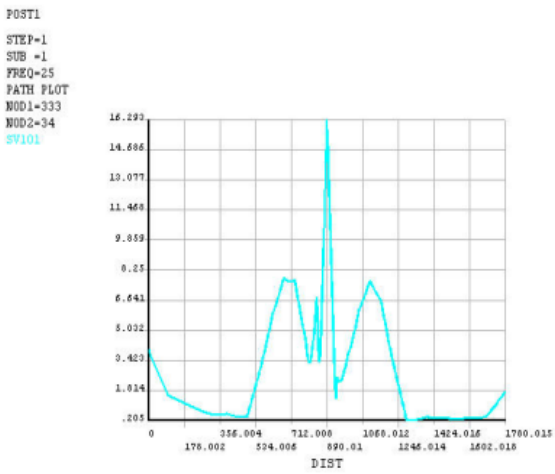


X direction Stress harmonic response curve

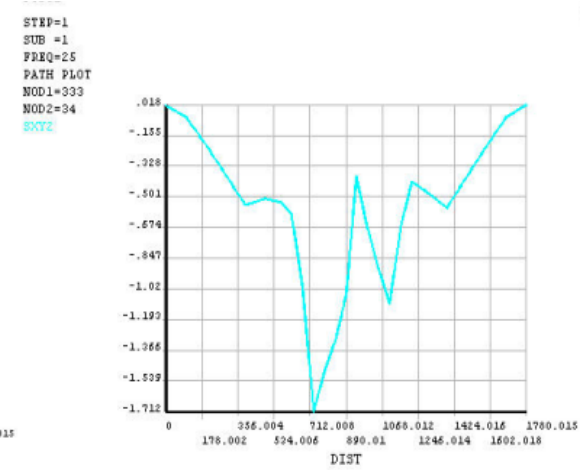


Y direction Stress harmonic response curve

(b)



Equivalent stress harmonic response curve



Shear stress harmonic response curve in Z direction

(c)

Fig 4. Node Harmonic Response Curve

Figures 2-4 show that when the vibration frequency ranges from 0 to 25 Hz and the excitation force is 50 000 N, the Y-direction displacement range of the groove body is 0.00019 mm to 0.0028 mm, and the equivalent stress range is 0.50511 Mp to 31.88 Mp. The overall average stress of the groove body is 0.05 Mp, and the main stress is concentrated on the bottom of the groove body and the front and rear steel plates.

3.2 Analysis Results of Slot Vibration Polishing Machine with Frequency Ranging from 0 Hz to 25 Hz and Load of 60 000 N

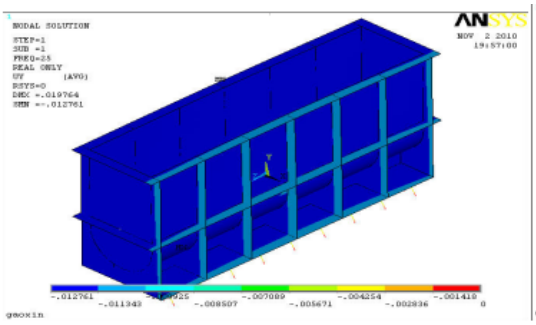


Fig 5. Deformation nephogram in Y direction

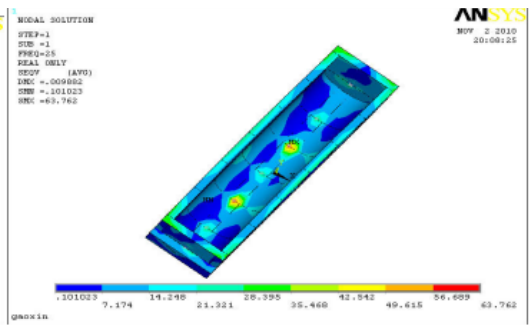
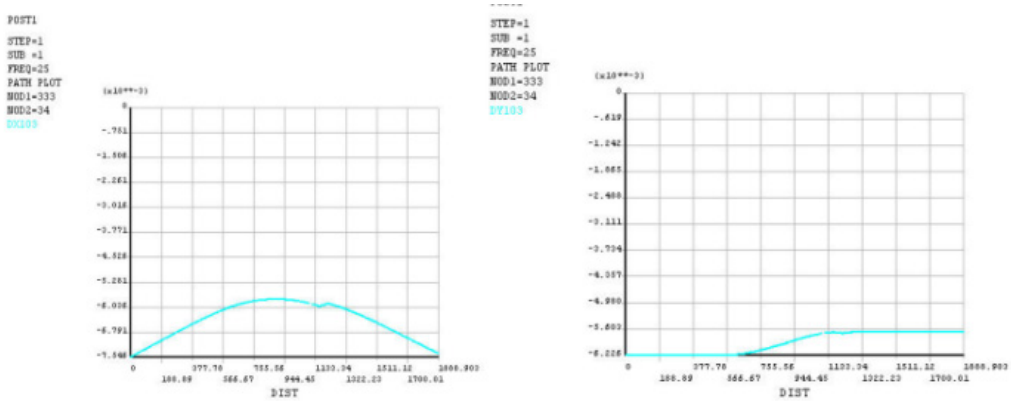
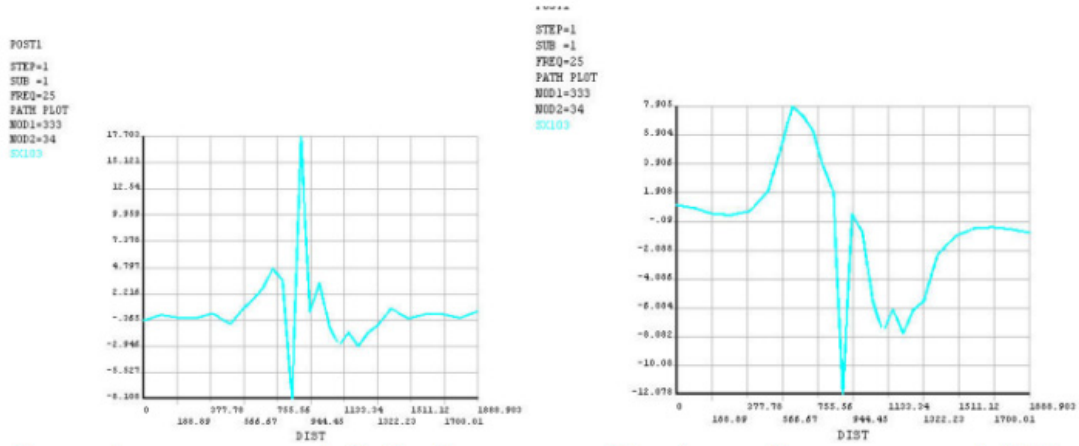


Fig 6. Equivalent stress nephogram



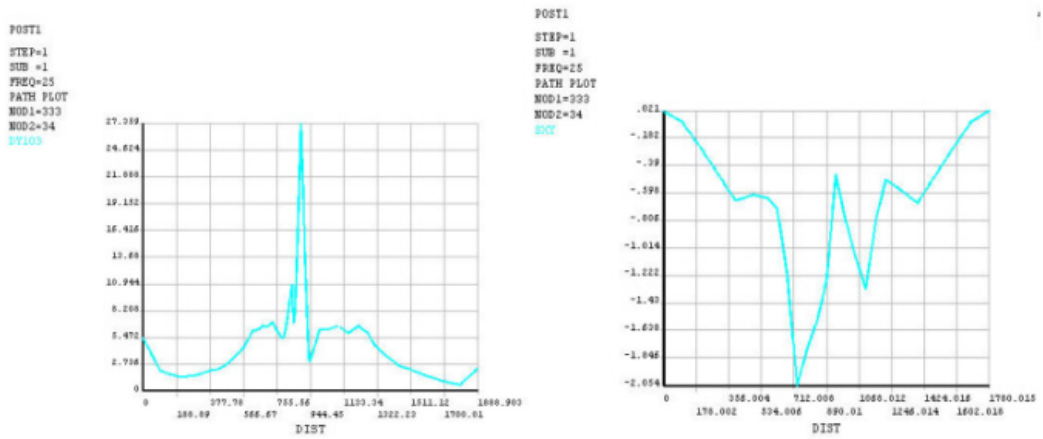
X direction displacement harmonic response curve Y direction displacement harmonic response curve

(a)



Stress harmonic response curve in X direction Stress harmonic response curve in Y direction

(b)



Equivalent stress harmonic response curve Shear stress harmonic response curve in Z direction

(c)Harmonic response curve of shear stress in Z direction

Fig 7. node harmonic response curve

Fig. 5-7 shows that when the vibration frequency ranges from 0 to 25 Hz and the exciting forceis 60 000 N, the Y-direction displacement range of the groove body is 0.0014 mm to 0.0028 mm, and the equivalent stress range is 0.101023 Mp to 63.762 Mp. The overall average stress of the groove is 0.1 Mp.

3.3 Analysis Results of Slot Vibration Polishing Machine with Frequency Ranging from 0 Hz to 50 Hz and Load of 50 000 N

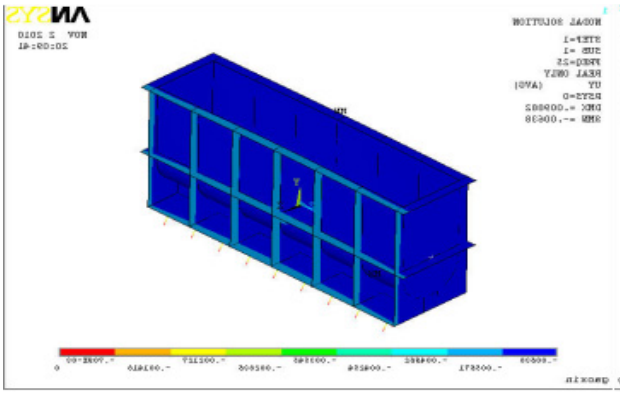


Fig 8. deformation cloud diagram in Y direction

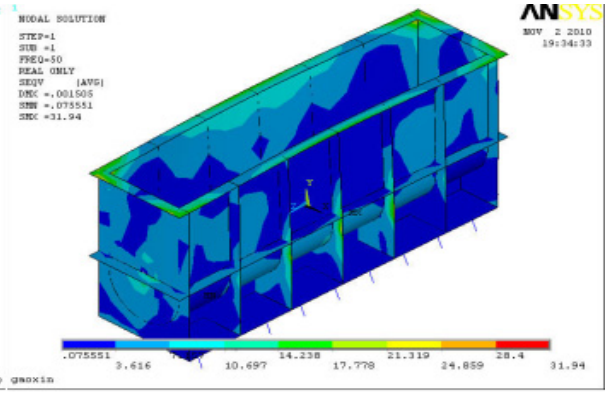
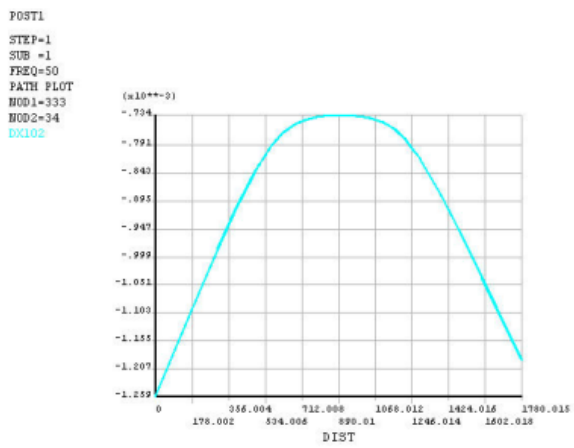
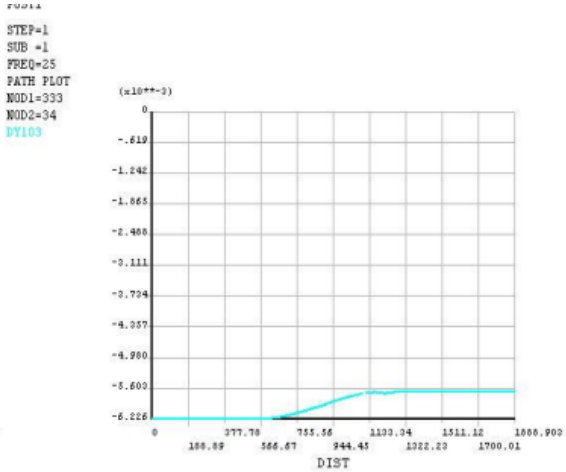


Fig 9. equivalent stress cloud diagram

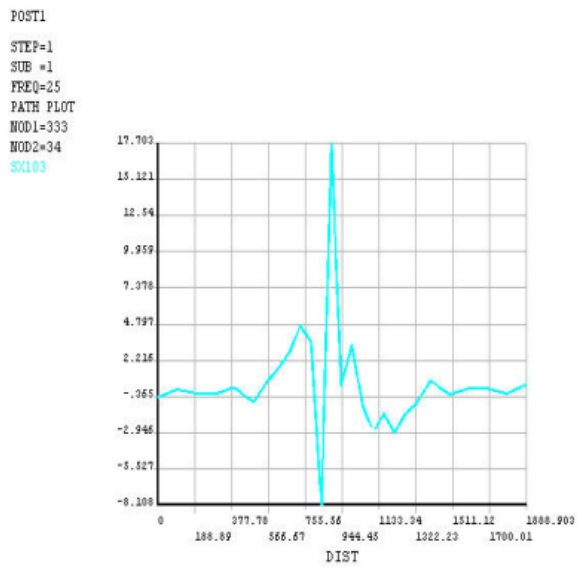


X direction displacement harmonic response curve

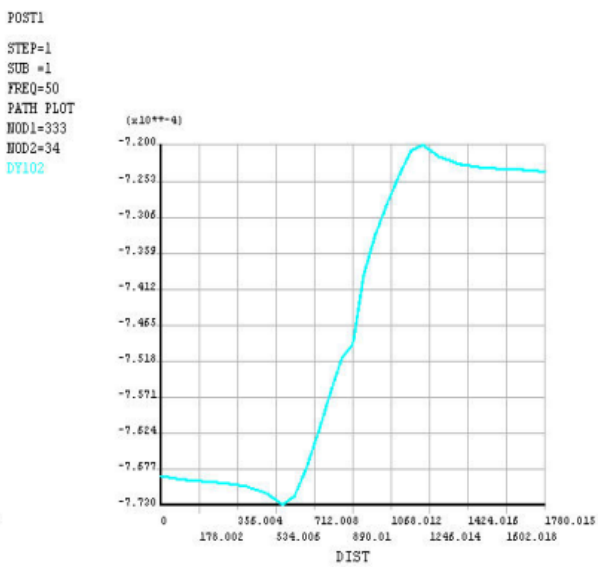


Y direction displacement harmonic response curve

(a)

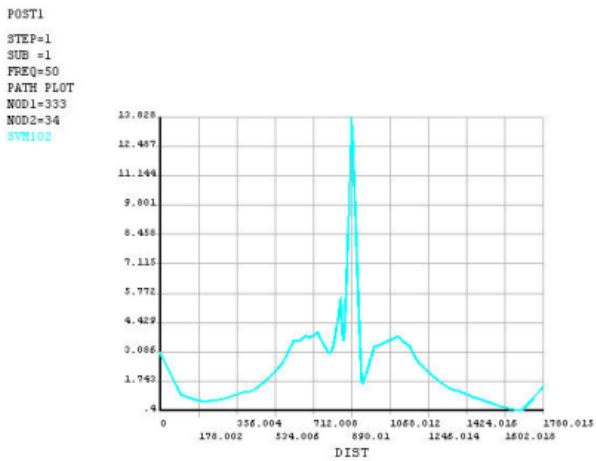


Stress harmonic response curve in X direction

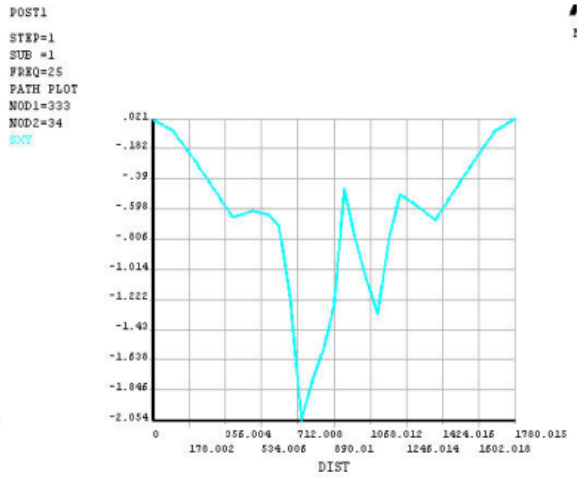


Stress harmonic response curve in Y direction

(b)



Equivalent stress harmonic response curve



Shear stress harmonic response curve in Z direction

(c)

Fig 10. node harmonic response curve

As shown in Fig. 8 ~ 10, when the vibration frequency range is 0 ~ 50Hz and the excitation force is 50000N, the y-direction displacement range of the tank is 0.0007mm ~ 0. 006mm.The equivalent stress range is 0.0755Mp ~ 31.94 Mp. The overall average stress of the tank was 3.6Mp.

4. Analysis and Summary

Because the sieve body is made of Q235A, its allowable stress value is given according to yield limit, its value is s=235 MPa, the general dynamic stress safety factor is k_b=3~9, and k_b=6-9, then $[\sigma]==\frac{\sigma_s}{k_b}=39.2$Mp.

when the vibration frequency range is 0-25 Hz and the excitation force is 50000 N, the maximum stress is 31.88 Mp <[σ], so the vibration polishing machine can meet the allowable stress requirement of materials. And the overall deformation of the groove body is not large, so it meets the design requirements.

When the vibration frequency ranges from 0 to 25 Hz and the exciting force is 60 000 N, the maximum stress is 63.76 Mp > [σ], so the vibration polishing machine cannot meet the material allowable stress requirements. Therefore, the design scheme does not meet the requirements.

when the vibration frequency ranges from 0 to 50 Hz and the exciting force is 50,000 N, the maximum stress is 31.94 Mp <[σ], so the vibration polishing machine can meet the allowable stress requirements of materials. However, the deformation of the latter is larger than that of the former when the vibration frequency ranges from 0 Hz to 25Hz.

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