Prediction of safe working frequencies of screening machine by Harmonic Analysis

Hajare Prashantbhai A

Assistant Professor, Vadodara Institute of Engineering,
Kotambi, Vadodara, Gujarat India

ABSTRACT

The vibratory screening machine is used in different industries like mining, pharmaceutical, food etc. In the past, the study of screening machine has been done on the basis of its design parameters like diameter of wire, length, mesh size, throwing index etc. The work regarding vibration parameters is not widely done in the past. A little work on mathematical modeling has been done on the rectangular type vibratory screening machine. In this paper modal and harmonic analysis has been done to predict the natural frequencies of different mode shapes of the circular vibratory screening machine. This analysis can be used as the methodology for the further study of the VSM. In this dissertation work it the design and working frequencies of the screening machine are of safe region.

Keywords: Modal Analysis, Harmonic Analysis, Natural frequencies of Vibrating screening Machine

INTRODUCTION

Industrial screens are used in the minerals processing industry to separate solids from liquids and to separate particulate materials into different size ranges. Screening has been extensively used since the Greeks used horse hair-and-reed sieves to effect particle size separation. The first woven wire screens dates back to the 15th century Germany and remain largely unchanged today. Sieves and screens are used
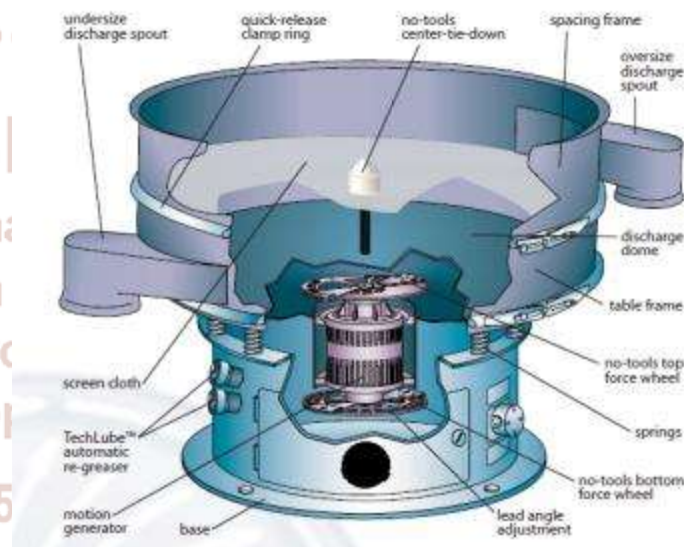

Figure 1: Vibratory Screening Machine

both industrially and in the laboratory to classify particulate material by particle size. The term "screening" is commonly used to mean a continuous sizing operation as distinct from sieving, which is a

batch operation. The principles of size separation during screening and sieving are the same. Even in these early times, it was realized that shaking the screen by hand the efficiency of the screening process is improved.

Basically, the vibrating screening machine vibrates about its centre of mass. Vibration is accomplished by eccentric weights on the upper and lower ends of the motion-generator shaft. Rotation of the top weight creates vibration in the horizontal plane, which causes

material to move across the screen cloth to the periphery. This is the reason why conventional systems cannot be used with slightly sticky and/or agglomerating materials, with heavy meshes (over 300 microns) or with large machines, especially rectangular screeners. On the contrary, the energy output capabilities of the Vibratory Screening Machine are so huge, that practically all kinds of materials are de-agglomerated and clogging of the mesh by any powder or slurry is avoided. Therefore the Vibratory Screening Machine can easily work with all meshes from 15 microns to 30 mm

MODAL ANALYSIS

A Model of Vibrating Screening Machine using

Figure 2: Vibrating screening machine using creo 2.0
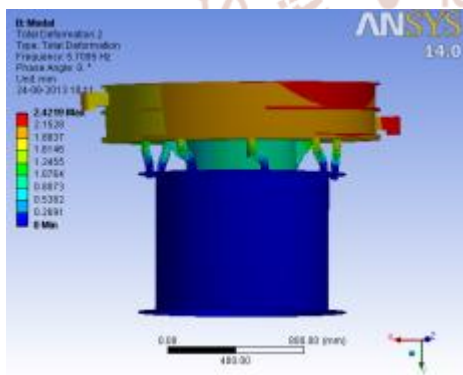
Modal Analysis of vibrating Screening Machine:

Figure 3: Mode shape of 2nd Mode frequency

Fig shows the initial motion for second mode of frequency which indicating horizontal and vertical motions of screen. By observing the figure we can conclude that the maximum deformation generated on the frequency of 5.7095 Hz.
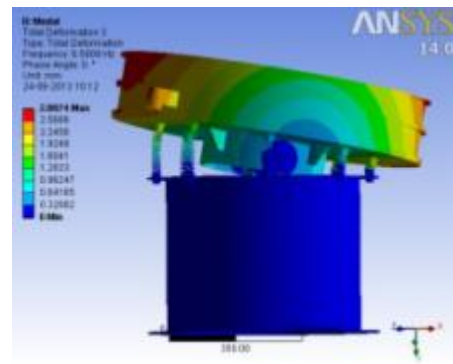

Figure 4: Mode shape of 4nd Mode frequency

In Figure, we can clearly observe all three motions of VSM. For the third mode of frequency the maximum deformation or the maximum amplitude is observed at the frequency of 6.5909 Hz.
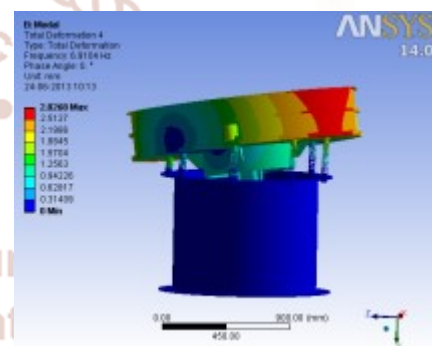

Figure 5: Mode shape of 4nd Mode frequency

In figure the maximum amplitude is at the frequency of 6.9104 Hz. The Modal analysis is done for finding the natural frequencies of the VSM. In this analysis we have considered six natural frequencies for finding its mode shapes and to observe and analyze the different motions of VSM.

As the result of Modal analysis the six natural frequencies for six modes of vibrating screening machine are listed in the table given below. The frequency for first mode is 2.0308 Hz and that for the sixth mode is 48.412 Hz.

The all six natural frequency for six modes of VSM

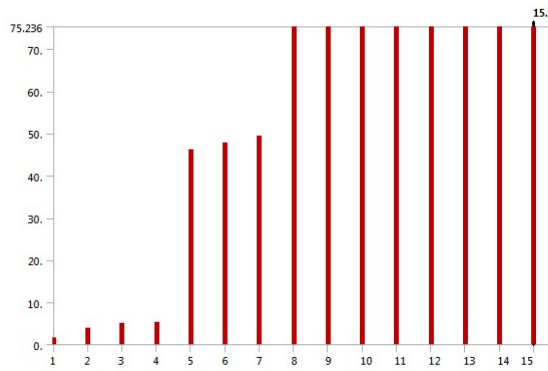| Mode	Frequency [Hz]
1	2.0308
2	5.7095
3	6.5909
4	6.9104
5	46.843
6	48.412

HARMONIC ANALYISIS

Figure 6: Modes v/s Frequency by harmonic analysis for the actual frequency range
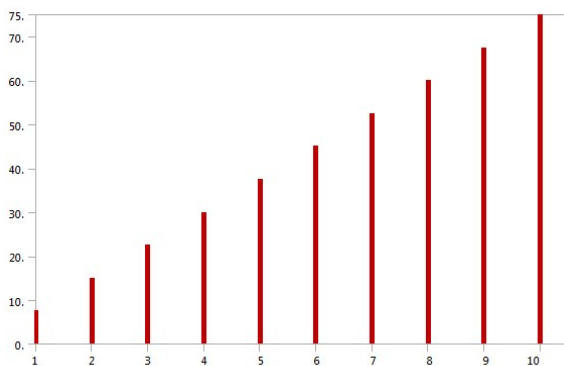

Figure 7: Modes v/s Frequency by harmonic analysis for the preferred frequency range

Frequencies of actual harmonic analysis and of preferred range:

Mode	Actual Frequency [Hz]	Preferred Frequency [Hz]
1.	1.6542	7.5
2.	3.9896	15
3.	5.0903	22.5
4.	5.3485	30
5.	46.194	37.5
6.	47.743	45
7.	49.367	52.5
8.	75.191	60
9.	75.195	67.5
10.	75.198	75
11.	75.213	75
12.	75.216	75
13.	75.221	75
14.	75.224	75
15.	75.236	75

RESULTS

		Deformation Y Direction	
Sr. No.	Frequency [Hz]	Amplitude [mm]	Amplitude [mm]
1	7.5	0.13074	0.13074
2	15	0.14105	0.14105
3	22.5	0.16166	0.16166
4	30	0.20315	0.20315
5	37.5	0.30315	0.30315
6	45	0.76449	0.76449

		Deformation X Direction	
Sr. No.	Frequency [Hz]	Amplitude [mm]	Amplitude [mm]
1	7.5	1.10E-03	1.10E-03
2	15	4.74E-05	4.74E-05
3	22.5	2.56E-04	2.56E-04
4	30	5.12E-04	5.12E-04
5	37.5	1.31E-03	1.31E-03
6	45	1.14E-02	1.14E-02

		Deformation Z Direction	
Sr. No.	Frequency [Hz]	Amplitude [mm]	Amplitude [mm]
1	7.5	1.62E-04	1.62E-04
2	15	4.10E-04	4.10E-04
3	22.5	6.17E-04	6.17E-04
4	30	1.02E-03	1.02E-03
5	37.5	2.48E-03	2.48E-03
6	45	3.89E-02	3.89E-02

CONCLUSIONS

By the Harmonic Analysis done on Vibrating Screening machine, it is observed that the maximum amplitudes of deformation in X, Y and Z directions are 0.011442, 0.97638 and 0.038935 mm respectively. And these amplitudes are at safe frequency range for the optimal screening process.

The frequency range for these amplitudes is 45 Hz to 52.5 Hz. This frequency range is the safe working range for the VSM.

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