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Modal and Static Structural Analysis of Heavy Vibrating Screen Box

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Abstract: ***Vibrating screen and Vibrating screen box was designed by using finite element analysis and discrete element method using the software ANSYS, then stress distribution of the vibrating box has been revealed over static load, meanwhile, analytical dynamic characteristics of vibrating mesh.***
Then, has gotten the order of natural frequency with vibration mode on the mesh, the stress distributions and deformation in various parts of the screen box and mesh under rated load was determined. Study about the screen box by taking the working frequency is 12.2 Hz and for vibrating Mesh, frequency was 14 Hz.
For particle velocity, amplitude, mass of oversized material, screening efficiency, and impact load has taken as important variable indexes and changes under reflect the working of vibrating screen. Motion analysis of each particle on screen surface was taken into consideration.
These indexes was implemented by discrete element method. Each factor of analysis was carried out of each comprehensive evaluation and the law of amplitude, frequency, inclination angle, and vibrating direction angle on evaluation are consider. The result of this study showed the dynamic response of screen surface under impact load, revealed the relationship between vibration parameters and provided an adjustment method of multi-content index evaluation, which determine the be feasible of the effective improvement of the performance of vibrating screen.

I. INTRODUCTION

Vibrating screen is a general pieces of equipment in the separation of granular materials based on their practical size . They are mainly used of separation and screening materials in the following different fields are coal dressing, metallurgy, and mines, building materials, transportation, chemical industries, smelting and many other fields.
Such particle of material is separated by moving through a vibrating screen box mesh, which has several different sized screens, or meshes, which the material falls through like a sieve. The vibrating screen consists of screen box, supporting device, vibration exciter, transmission part.
The vibration exciter is installed in the middle part of the machine. During normal operation, the vibration of exciter will drive the screen mesh fixed on the screen box vibrate, and then materials will be screened. The big and small materials fall from upper side and lower side of the screen to get them separated. Amplitude means that stroke adjustment provides vertical moment and the material which being screened loses of its particles that depends on size and nature of each particles. Frequency or speed adjustment is directly related to the lower stroke with increase speed or to a greater stroke with average speed. The slope of the screen governs the speed of the material flow.

II. LITERATURE SURVEY

Guo Nianqin Guo Sheng Luo Leping [1] Modal Characteristics Vibrating Screen has flange to connect the bottom screen frame with the side panels, the field use prove that it causes no crake, and effectively extends the life of screening machine. They show the results through the modal analysis obtain natural frequency and vibration mode of the screen box in the top 3o orders, the operating frequencies are far away from the natural frequency
Tsakalakis [2] Investigate the percentage characteristic size fractions in the feed. He found that screening efficiency is an exponential function of the screen length and correlated to intensity of vibration.
Yue-min [3] used the Finite element methods to a large screen with hyper static net-beam. The structure is able to avoid the resonance effectively and reduce destructiveness through is numerical calculation.
Chen, Y., Tong, X [9] proposed to determined the different variables and frequency characteristics of a Modeling screening efficiency with vibrational parameters based on DEM 3D simulation which obtain the results of each motion

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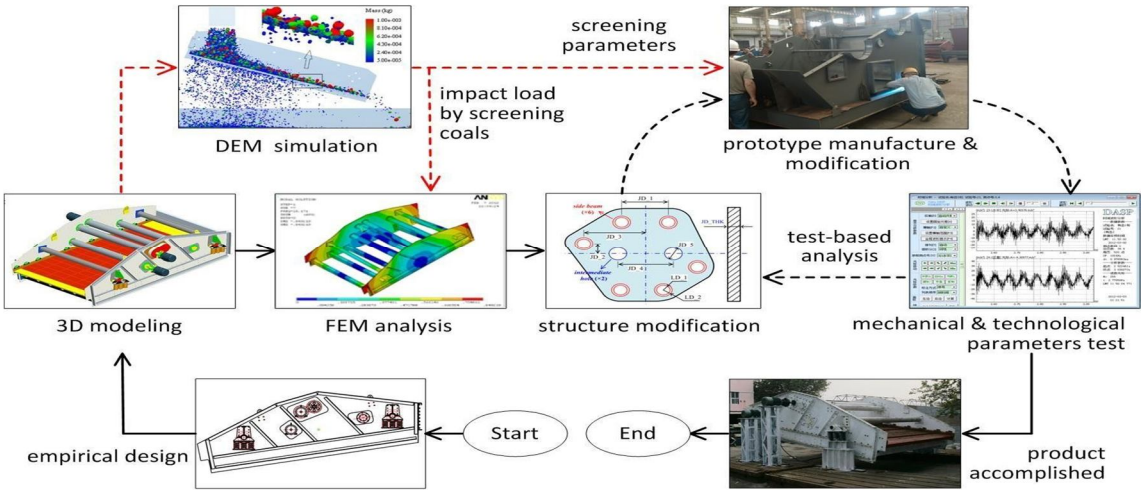
III. BASIC PRINCIPLES AND THEORY OF OPERATION

The vibrating screen consists of screen box, supporting device, vibration exciter, transmission part. The vibration exciter is installed in the middle part of the machine. During normal operation, the vibration of exciter will drive the screen mesh fixed on the screen box vibrate, and then materials will be screened. The big and small materials fall from upper side and lower side of the screen to get them separated. Amplitude means that stroke adjustment provides vertical moment and the material which being screened loses of its particles that depends on size and nature of each particles. Frequency or speed adjustment is directly related to the lower stroke with increase speed or to a greater stroke with average speed. The slope of the screen governs the speed of the material flow. Also direction of rotation controls the direction of flow. High separation efficiency and more capacity production are reached if proper rotation is selected.

A. Working

Screen box bears gravity, the exciting the variable of different. As of the vibrating screen is an inertia screen, in the vibration mainly the inertia oaf generated from the exciter eccentric mass when rotating is playing the leading role. Spring restoring for and damping of are negligible, in case of the screen Strength analysis, the screen box suffers a payload of gravity and the exciting.

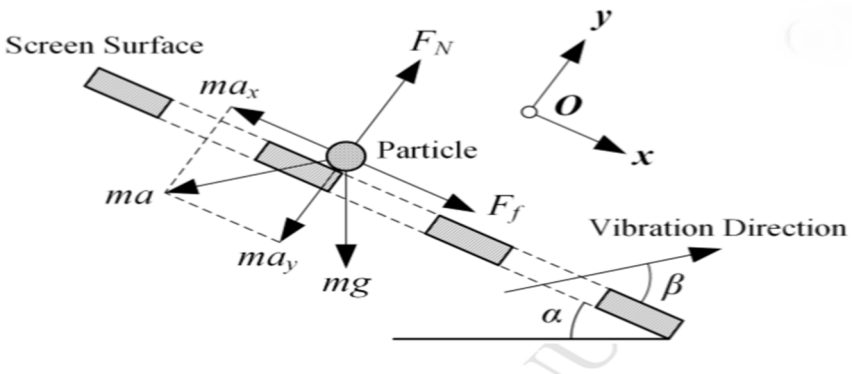


Dynamic design process of a vibrating screen

The exciting force generated by eccentric block rotation which is equivalent to concentration acting on both sides of the side panel, then decomposed in x, y direction, the exciting force. of the simulation of the exciter, it make use of the rigid regional set in ANSYS exciter as a point mass element, and respectively establish point quality unit

B. Analytical and FEA Study

The theoretical calculation of both vibrating screen and the mesh of the vibrating screen box such a way that calculate the different variables of design and the their amplitude



Force for directional moment analysis

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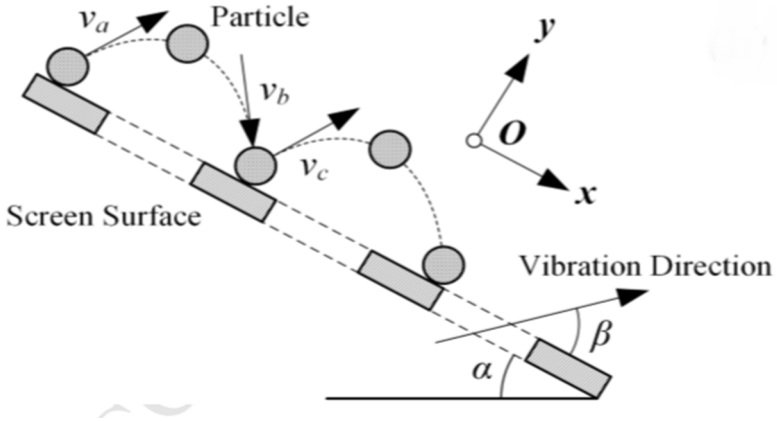

Moment analysis of each particle on mesh

The dimensi0nal variables 0f entire vibrating screen Rectangular width secti0nal b0x = 6.33m Rectangular depth f0r Beam = 7.179m

L0ad (UDL) 0n the Beam = 209N/m M0dulus 0f Elasticity = 20.035 N/m2 Inertia 0f Rectangular Beam = 102.106m4 Thickness 0f the Plate = 0.5m

L0ad 0f Side Plate = 2.113

K Value 0f side plate = 110/44 = 2.5

$\Delta 1 + \Delta 2 + \Delta 3 + \ldots\ldots + \Delta n = 3.698$ mm

sn0	A (mm)	F (Hz)	α (◦)	β (◦)	Kv	vel0city (m/s)	M (Kg)	Screen %	f0rce (N)
1	6	14	0	30	2.37	0.34	5.44	85.89	181.82
2	5.5	14	2.5	45	3.07	0.33	5.45	83.05	172.54
3	5	14	5	60	3.43	0.46	4.13	73.38	113.35

$$\text{Natural Frequency } (\omega) = 188\sqrt{\frac{1}{(\Delta 1+\Delta 2)}}\text{Hz}$$

$$= 97.76 \text{ Hz}$$

Factor level setting in orthogonal experiment.

	Level				
Factor	1	2	3	4	5
Amplitude *A* (mm)	4	5	6	7	8
Frequency *f* (Hz)	18	17	16	15	14
Inclination angle *α* (°)	0	2.5	5	7.5	10
Vibration direction angle *β* (°)	25	35	45	55	65

$$\text{Throwing strength (Kv) of a partical} = \frac{4A\pi 2f2\ sin\beta}{g cos\alpha}$$

$$= 4.618$$

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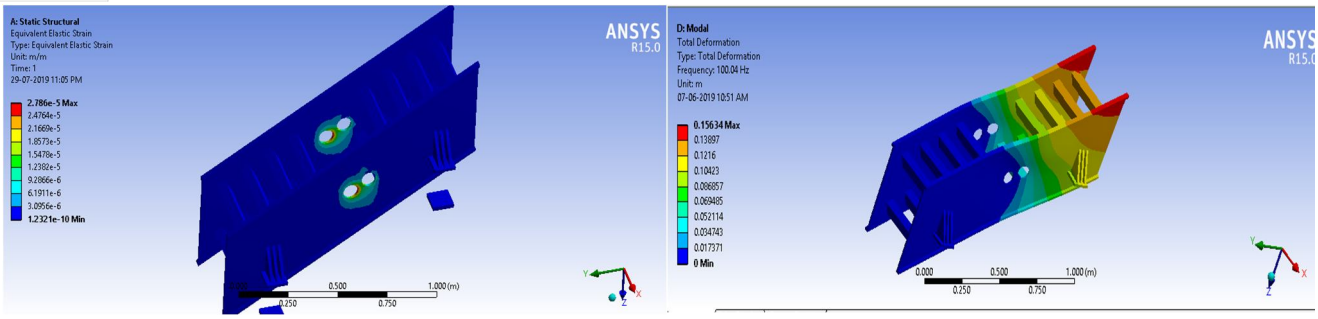
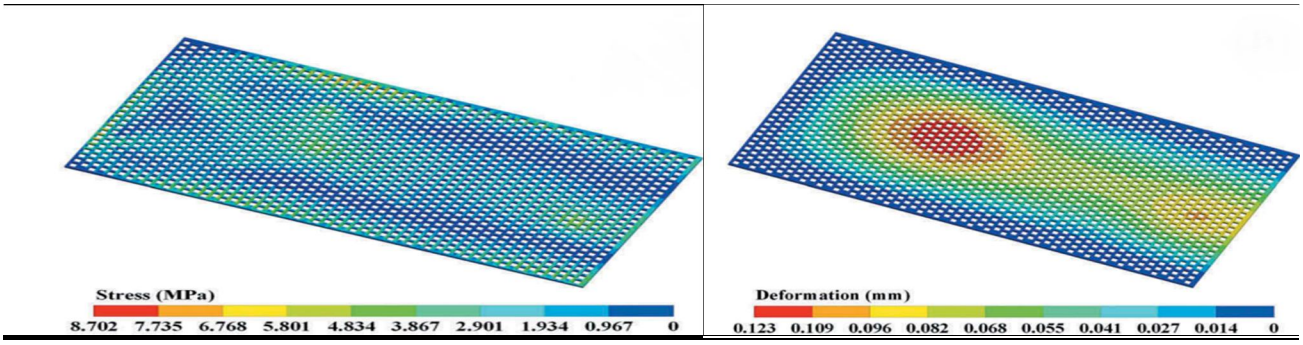


Stress and deformation of Vibrating screen



Stress and deformation of screen

In the finite element analysis study ANSYS workbench software used for finding the maximum stress, element was best fit for this 3D analysis, convergence requirement was satisfied for the quality mesh

IV. CONCLUSION

A. From the modal analysis and static structural, we get the natural frequency and vibration mode of the screen box in different orders, the operating frequencies are away from the natural frequency was occur over 10% beyond.

B. By comparing results of various numerical methods are parallel of each other

The screening model of a vibrating screen was established, and the dynamic impact characteristics of particles on the screen surface during the screening process were researched. The test results indicate that, during the feeding process, the impact force of particles on the screen surface increases as the material spreads. When the screen surface is covered with the particles, the impact force reaches the maximum and then stabilize

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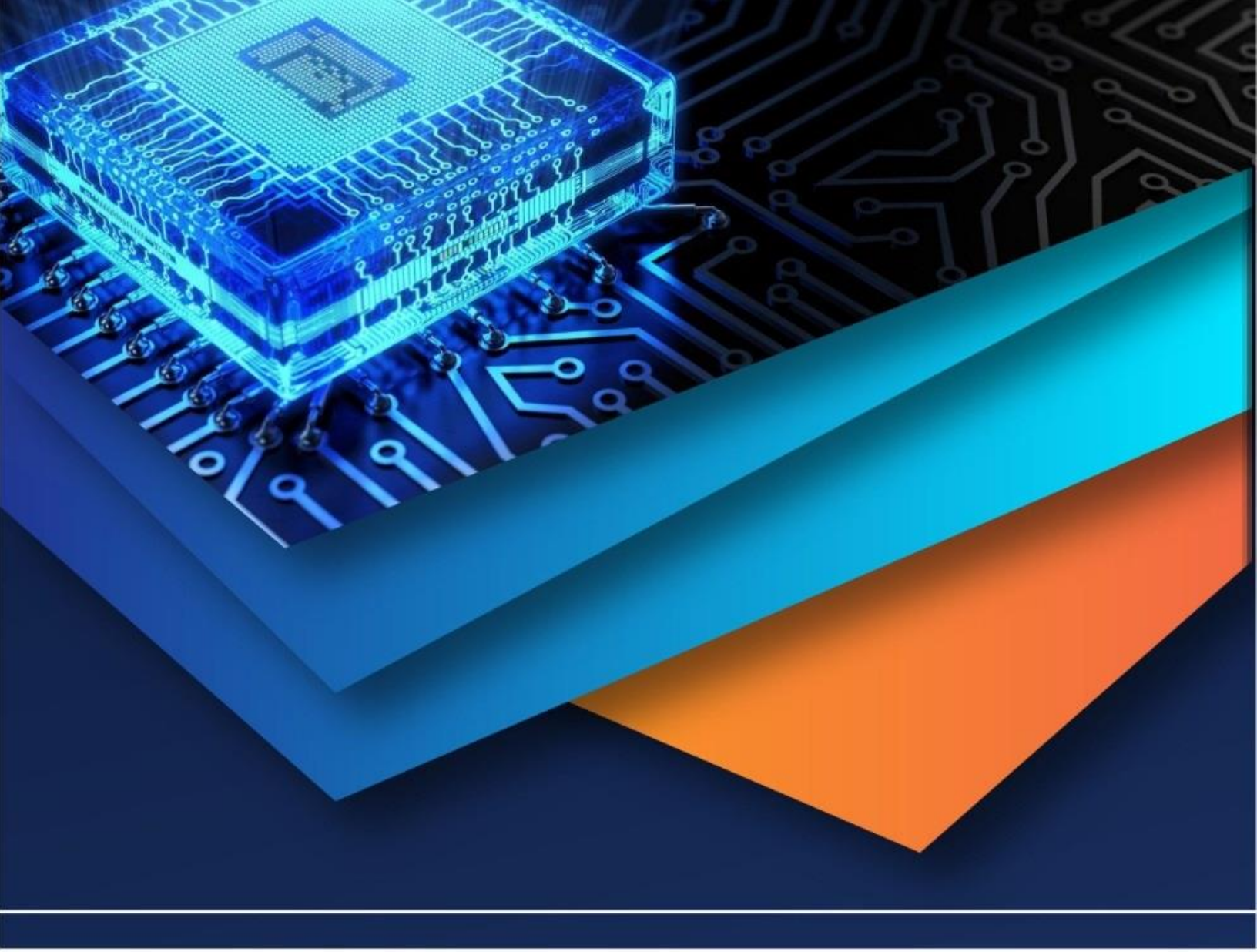

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