DESIGN AND EXPERIMENTAL ANALYSIS OF CONNECTING PLATE OF RECIPROCATING VIBRO SCREEN

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ABSTRACT

Vibro separator / screen is suitable for wet/dry, grading, classification, de-dusting, and quality control. The multi-purpose model is essential to improve quality and safety of production materials, increase productivity, and reduce cost and labour. It has 1 to multiple screens depending upon application and model. The parts are made from MS (mild steel), SS(stainless steel) 304, SS (stainless steel) 316.so the force analysis is done and modification is suggested.

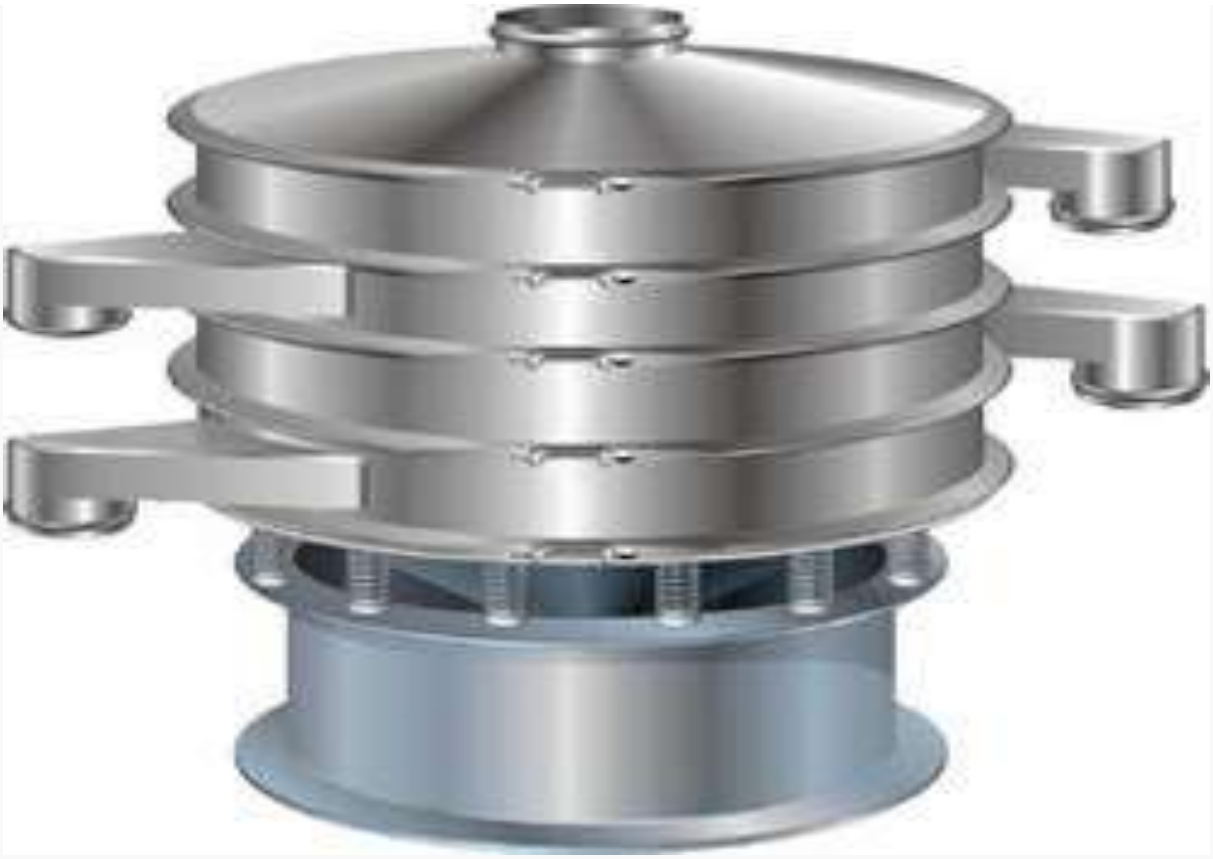
Keyword : - *Modelling, Force Analysis, Modified Design of separator etc….*

1. INTRODUCTION

1.1 There are two types of vibro screen as per configuration :

(1) rotary type vibro screen

(2) reciprocating type vibro screen

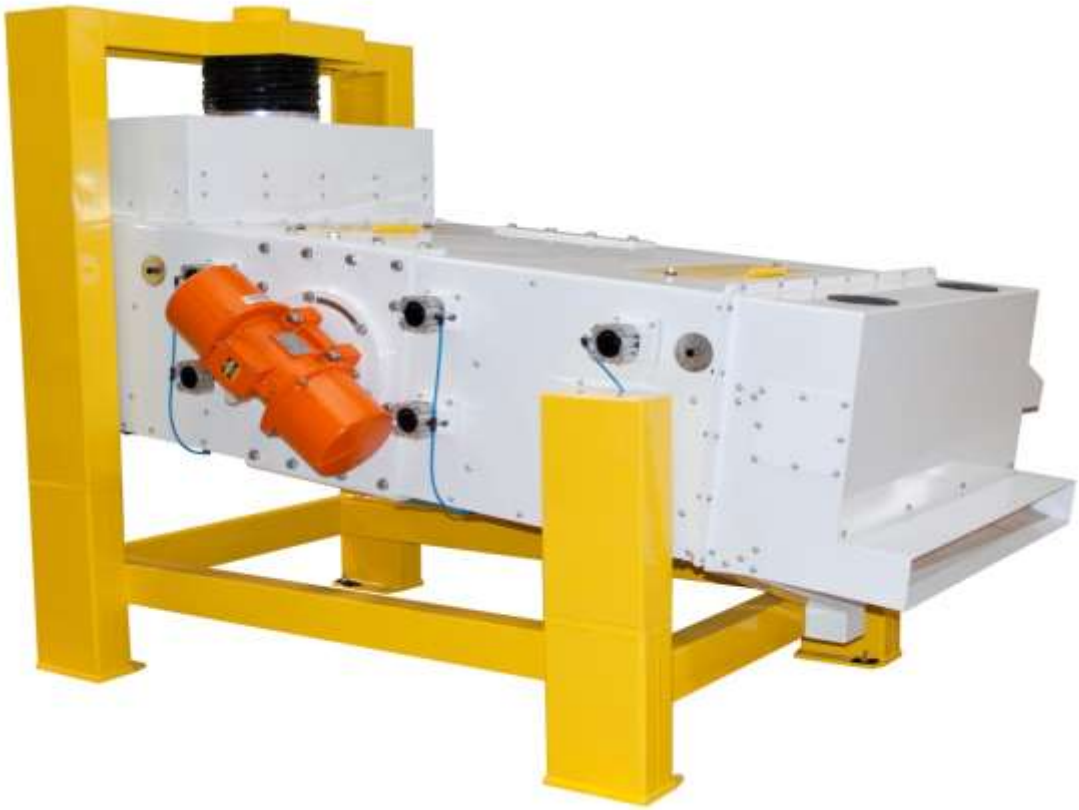


Fig(1.1) rotary type vibro screen

1.2 History：In the early 1930s, most vibratory separators had a rectangular or square design employing simple reciprocating movement. After the introduction of machines utilizing gyratory motion with orbital movements, there was a huge change in machinery industry due to the much greater screen area usage and capacity per unit mesh area.

1.3 Fundamental principle of rotary type vibro screen：Gyratory equipment contains decks of screens on top of each other with the coarsest screen on top and the finest below. The feed is inserted from the top and gyratory motion triggers the penetration of particles into the next deck through screen openings.

Casings are inclined at relatively low angles (< 15°) to the horizontal plane, with gyrations occurring in the vertical plane. The eccentric masses can be varied in such as the increase of top eccentric mass leads to an increase in horizontal throw, promoting the discharge of oversize materials. Increment in bottom eccentric mass boosts the material turn over on the screen surface, maximizing the quantity of under-size-material penetration. Over size materials are discharged via tangential outlet.



Fig(1.2) reciprocating type vibro screen

1.4 Fundamental principle of Reciprocating type vibro screen :

Linear vibrating screen is designed with dual-vibration motor drive,two synchronous motors are reversely placed so that the exciter generate reverse excitation force, the exciting force generated by eccentric block cancel each other out on the parallel direction of motor axis,and stack together with the perpendicular direction of motor axis, so its trajectory is linear.Linear vibrating screen is suitable for particle size from 0.074 -5 mm, the maximum size should be less than 10mm. Linear vibrating screen is widely used in agriculture, mining, coal, refractories, metallurgy , building materials and other industries. It is usually used for the screening and grading materials in large, middle and small particles.

1.5 Components of Reciprocating type vibro screen :

(1) external body

(2) vibro motors

(3) damping medium

(4) vibro screens

(5) connecting plates

A complete focus of this project is on design and analysis of connecting plate of reciprocating / linear type vibro separator.

The connecting plates are the intermediate medium between vibro motors and body of vibro separator .

There are two vibro motors used in linear type vibro screen. Each having unbalanced mass incorporated in it. Both the motors have same direction of rotation.

The vibration that are generated by the rotation of the vibro motors having unbalanced masses are transmitted by connecting plates to the body of vibro separator.

There are two plates joined by welding or bolted on each side of the linear type vibro screen.

The vibro motors are bolted with the connecting plates on each side.

1.6 Advantages and Features :

1. Less energy consumption, lower noise, longer service life
2. The beam and screen box are connected by high strength blot without welding
3. High accuracy screening efficiency, simple and stable structure, convenient maintenance
4. Suitable for rough screening with high capacity
5. Long travel distance for materials on the screen surface, high screening efficiency

1.7 Application industry:

- Agro / Seed Processing
- Agro Product Processing
- Ayurvedic Industry
- Bakery Industry
- Barking Drums (Effluent)
- Brewery
- Bulk Foods
- Calcium Carbide.
- Calcium Carbonate Powder.
- Cattle Feed
- Cement
- Degritting Milk Of Lime Slurry
- Dehydrated Food
- Detergents
- Electrode
- Engineering
- Extrusion
- Ferro
- Fertilizers
- Fish Press Liquor
- Fisheries
- Flour Mill

2. LITERATURE SURVEY

(1) Buckling, free vibration and bending analysis of functionally graded sandwich plates based on an optimized hyperbolic unified formulation

J.L. Mantari , JC Monge

International Journal of Mechanical Sciences

This paper presents an analytical solution of the linear buckling, free vibration and bending behavior of simple supported functionally graded sandwich plates subjected to transverse and axial mechanical loads. The used

optimization strategy allows to express the transverse and in-plane displacement fields as a function of the *n* and *m* parameter, respectively,

(2) A Study on the Structural Behaviour of FGM Plates Static and Free Vibrations Analyses

G.M.S. Bernardo, F.R. Damásio, T.A.N. Silva, M.A.R. Loja

Functionally graded materials are characterized by a determined spatial composition variation of their phases' constituents, which enable for a closer suitability of the material properties to the desired mechanical behaviour. Concerning to the engineered construction of these materials, they can be thought as being achieved by considering a continuous variation of their phases and thus of their properties, or by considering a discrete stacking of a sufficient number of layers, in order to ensure a less abrupt variation profile of their properties. Also, depending on the nature of the applications, it may be important to consider a sandwich configuration, where the three-layered constitution may correspond to a functional requisite. With the present work, these two situations will be studied, considering different methodologies based either on a meshless method or on different approaches based on the finite element method. A comparative study of the performance and adequacy of the developed models is carried out through a set of illustrative cases focused on the study of static and free vibrations behaviour of plate structures.

(3) Three-dimensional free vibration analysis of functionally graded annular sector plates with general boundary conditions

Guoyong Jin , Zhu Su , Tiangui Ye, Siyang Gao

The main purpose of this paper is to investigate free vibration behaviors of functionally graded sector plates with general boundary conditions in the context of three-dimensional theory of elasticity. Generally, the material properties of functionally graded sector plates are assumed to vary continuously and smoothly in thickness direction. However, the changes in the material properties may occur in the other directions, such as radial direction. Therefore, two types of functionally graded annular sector plates are considered in the paper. In this work, both the Voigt model and Mori-Tanaka scheme are adopted to evaluate the effective material properties. Each of displacements of annular sector plate, regardless of boundary conditions, is expressed as modified Fourier series which consists of threedimensional Fourier cosine series plus several auxiliary functions introduced to overcome the discontinuity problems of the displacement and its derivatives at edges. To ensure the validity and accuracy of the method, numerous examples for isotropic and functionally graded sector plates with various boundary conditions are presented. Furthermore, new results for functionally graded sector plates with elastic restraints are given. The effects of the material profiles and boundary conditions on the free vibration of the functionally sector plates are also studied.

(4) Three-dimensional vibration analysis of layered and functionally graded plates through sampling surfaces formulation

G.M. Kulikov, S.V. Plotnikova, M.G. Kulikov, P.V. Monastyrev

The paper deals with a recently developed method of sampling surfaces (SaS) and its implementation for the three-dimensional (3D) free vibration analysis of layered plates with embedded functionally graded (FG) layers. The SaS method is based on choosing inside the *n*th layer In not equally spaced SaS parallel to the middle surface of the plate in order to introduce the displacements of these surfaces as basic plate variables. Such choice of unknowns with the consequent use of Lagrange polynomials of degree In-1 in the assumed distributions of the displacements and mechanical properties through the thickness of the layer leads to the robust FG plate formulation. The SaS are located inside each layer at Chebyshev polynomial nodes that makes it possible to minimize uniformly the error due to the Lagrange interpolation. As a result, the SaS formulation can be applied efficiently to obtaining the analytical solutions for layered and FG plates, which asymptotically approach the 3D exact solutions of elasticity as the number of SaS tends to infinity

(5) Axisymmetric vibrations and buckling analysis of functionally graded circular plates via differential transform method

Analysis and numerical results for the axisymmetric vibrations of functionally graded circular plates subjected to uniform in-plane force have been presented on the basis of classical plate theory. The mechanical properties of the plate material are assumed to vary as a general function of thickness parameter. A semi-analytical approach namely, differential transform method has been employed to solve the differential equation governing the motion of such simply supported and clamped plates. The effect of volume fraction index and the in-plane force parameter has been studied on the first three natural frequencies of vibration. By allowing the frequency to approach zero, the critical buckling loads for both the plates have been computed. Two-dimensional mode shapes for specified plates have been plotted. A comparison of results has been presented

Force on connecting plate due to constant loading of unbalanced mass rotation is calculated Side wall failure is analysed for heavy loaded vibro separator

3.MATHEMATICAL MODEL

In the modal of reciprocating vibro separator, as motor is running at 1000 rpm the stress generated value generated is as follow**.**

$$\omega = \frac{2 \times \pi \times N}{60}$$

Where N= 1000 rpm

ω=104.72 rad/s

$F_c = mr\omega^2$

$= (3.35\times4)\times(30.15 \times10^{-3})\times(104.72)^2$

$= 4430.49$ N

Here the N is in changing from 980 RPM to 1020 RPM. Due to this centrifugal force F_c the pressure applied to the wall of separator box is

P=F/A

4.EXPERIMENTAL WORK

The experimental work is performed at **Gajanand industries** at **Unjha.** Where the setup was prepared as per the computational work. Here the two vibro motors are running at 1000 rpm. The variation in motor speed is ± 30 rpm. Motor having 0.5 Hp power of each vibro motor.

The Experimental Setup is running at 1000 rpm motor speed with 30 degree motor angle.

Figure (4.1) Experimental Setup in Gajanand Industries

Table 4.1.Specification of Reciprocating vibro separator

Component	Weight(Kg)	Material
Separator box	505.63	Structural steel
Plate	6.37	Structural steel
Foundation Rubber	0.335	Rubber
Each Motor without unbalanced mass	35.91	Gray cast iron

After the fatigue analysis the Life obtains approx 16 hours for lower side bolt and 12 hours for upper side bolt. That causes crack generation on connecting plate

5. RESULT AND DISCUSSION

in the present work force induced due to continues rotation of unbalanced mass is calculated for single plate vibro separator . the life of connecting plate is measured in fatigue loading condition for the same set up .also life of bolts is calculated. The life of bolts is about 14 hours approx in fatigue loading condition and life of single connecting plate is 17.43 hours approx. In the analysis Structural steel is taken as bolt material and connecting plate material From the analysis force generated due to unbalanced mass is 5kN

From analysis it is shown that the connecting plate life due to forces on single plate separator is 97900 seconds.

6. CONCLUSION

1. From the observation of stress induced on a vibro separator , we can concluded that stress induced on single plate vibro separator is more than double plate vibro separator .so, from the ansys calculations we suggest to use either two connecting plate or use single connecting plate with 20mm thickness
2. From the observation of fatigue life we conclude that life of double plate vibro separator is more than single plate vibro separator .
3. From all the above conclusions it is better to use double plate vibro separator than single plate vibro separator for application

7. REFERENCE

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(5) Axisymmetric vibrations and buckling analysis of functionally graded circular plates via differential transform method

Roshan Lal, Neha Ahlawat