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Solid Modeling and Analysis of Vibrating Grizzly Feeder (VGF)

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***Abstract*—*The project involved in this paper is a Vibrating grizzly feeder, 1200 TPH capacity designed by ELECON Engineering Pvt. Ltd. The main function of VGF is to convey the material by effect of creation of vibration. So Modal analysis of VGF should be carried out. In this paper based on structural vibration theory and theory of finite element model(FEM), the 3D model of VGF is made in Pro-E and analyzed on ANSYS-workbench 14. Vibration mode and frequency can be concluded by calculating of the VGF's FEM model. Further different loading conditions were applied on VGF and under this conditions deformation and Von Mises stress has been found out.*

Keywords: *Vibrating grizzly feeder (VGF), natural frequencies, modes, static structural analysis, ANSYS-14, 3-D parametric model, PRO-Engineer software.*

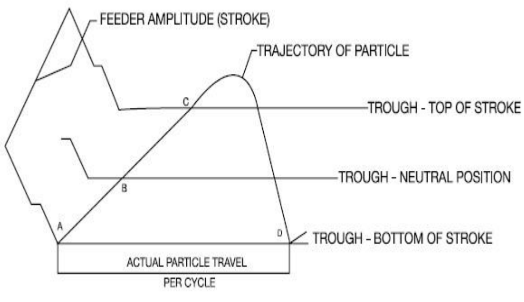
I. INTRODUCTION

The feeder is a piece of material handling equipment used to regulate the flow of a bulk material from a bin or hopper. A feeder is essentially a conveyor used for short distances where a constant rate of dispersal is required. There are many types of feeders to suit many different industries; ranging from mining, to pharmaceuticals, to agriculture. Feeders are often used in conjunction with other types of material handling equipment, like conveyors, crushers, dryers, grinders, blenders, and mixers

Feeders can be loosely classified as either volumetric or gravimetric:
- (I) Volumetric Feeder:
- (II) Gravimetric Feeder

Feeders are further segmented according to their method of conveying:
1. Apron feeder.
2. Belt feeder.
3. Chain feeder.
4. Rotary-Vane feeder.
5. Roller feeder.
6. Revolving disc feeder.
7. Screw feeder.
8. Vibratory feeder
9. Vibrating grizzly feeder.

A. Working principle of vibrating grizzly feeder:



MATERIAL FLOW ON TROUGH

Here vibration means "to move back and forth rapidly." On a vibratory feeder, material is "thrown" up and forward so that it drops to the surface at a point further down the tray. This is the feeder's amplitude. The number of times per minute that this repeats is the frequency. A third variable is the angle of deflection… meaning how high the product is thrown as compared to its horizontal movement.

The diagram (above) illustrates the action of a single particle of material moving along the tray's surface. During a vibrating stroke the tray surface travels between its lowest point "A" to its highest limit "C". On the upward stroke, the particle is in contact with the tray from "A" to "B". At that point the velocity of the particle become greater than the tray and the particle leaves the surface on a feed flight trajectory from "B" to "D". The particle lands forward on the tray at point "D". This completes one cycle. E.g. With equipment operating on a 60-cycle power supply, this cycle of material flow is repeated 3600 times per minute. Adjusting or varying the stroke of the tray controls the feed rate. The number of strokes will remain constant to the power supply. However, the stroke length can be varied by changing the voltage input to increase or decrease the feed rate. Each vibratory feeder or conveyor is designed with a different amplitude, frequency and angle of deflection in order to move different materials at specific rates. The equipment's design is based on many factors including the material being processed, flow rate of the process, nature of the environment, need to start and stop (cycle) the process, cost to operate the equipment and likelihood of repairs.

Such Vibrating Grizzly Feeder work on the phenomena of Vibration, so vibration is too much important in analysis of feeder. Therefore Natural Frequency of system is very important to study to save structure from resonance. It may destroy in any working condition, it will result in enormous economical losses .Modal parameters are the main parameters for such vibrating system. Therefore modal analysis is important for study of dynamic characteristics. Further different loading conditions also checked out.

II. LITERATURE REVIEW

Earlier work on vibratory bowl feeders was reported by Redford and Boothroyd [1]. They presented a theoretical analysis of vibratory feeding where a phase difference may exist between the parallel and normal components of track motion. Boothroyd et al. [2] studied the automatic feeding and orientation of parts on vibratory bowl feeders and developed various forms of orienting devices to improve feeding efficiency. Reynolds [3] considered the need to evaluate fully the vibratory feeder properties and the parts being conveyed. To develop a reliable mode1 to evaluate feed rates, Lonie [4] developed a simple model based on two masses connected by a spring and a damper and MacDonald and Stone [5] developed a simple linear vibratory feeder model using the MacPascal language. G.H.Lim perform dynamic analysis of a vibratory feeder[6]. He found that various factor such as deck inclination, amplitude, frequency, coefficient of friction could affect conveying velocity of moving body. He found that velocity of a body is particularly sensitive to coefficient of friction and deck inclination angle. He found that for a particular set of operating condition the vibratory feeder initially conveys body at an increasing velocity with increase in slope, and then after particular angle steady state velocity is achieved which corresponds to constant slope. He also developed the program to find capacity of feeder using Turbo C++. R. T. FOWLER and S. C. LIM[7] found that effectiveness of screen increases with increase in aperture, increase in slope of deck up to 15° and then further reduces, An increase in frequency of vibration to a certain maximum and then a decrease in effectiveness with higher frequencies.

III. SELECTION OF AMPLITUDE AND ANGLE OF INCLINATION FOR DRIVE

VGF work on the principle of creation of vibration, with vibrating movement material travels on trough and screen area. This vibration may produce by many way, such as (a) Brute force mechanical drive (b) Eccentric shaft mechanical drive (c) crank drive, we have to work for high capacity up to 1200 TPH, Crank drive is not suitable for such high capacity because rigid connecting rod makes it hard to start the conveying [8], So we have adopted Brute force mechanical drive, which is rotating unbalance mass drive and create vibration with certain amplitude. The program was developed on Turbo C++ by G.H.Lim, which gives the value of feed rate in m/s for particular Amplitude [9], Frequency, Angle of vibration and deck inclination. ELECON has developed design for VGF, which is going to analyze further in the paper. The angle of deck plate is kept 10° in the design and has decided to use 25Hz motor by ELECON, so these two values were put in the Turbo C++ program and finally we obtain the value of amplitude as 20mm and angle of vibration to 30°, which gives the velocity 4m/s, by putting the value in following formula the capacity find 1500 TPH, which is 25% higher than our capacity, which is over size and not screened. So we obtain capacity 1200 TPH.

$C=\frac{W*d*\rho*R*1000}{3600}$

C= Capacity of feeder in TPH

W=Trough width (2500 mm)

d=depth of material (25mm)

ρ=Bulk density= (1500 kg/m^3)

R= feed rate (4m/s)

IV. SOLID MODELING OF VIBRATING GRIZZLY FEEDER

VGF designed by ELECON mainly consist of components like six beams, deck plate, screen plate etc. Aim of the modeling is to achieve the natural frequency and effect of different loading condition on VGF.

Design data of the Vibrating grizzly feeder is taken from the ELECON Engineering Pvt. Ltd, V.V.Nagar. Based on the design data the parametric 3D model is made in mechanical PRO-Engineer software. The major components and their dimensions are given in the table-1, the component material properties are given in the table-2.

***Table I.* VGF major dimension and symbol**

Description	unit	value
Deck plate length	mm	1010
Deck plate width	mm	610
Deck plate thickness	mm	16
Screen plate length	mm	1010
Screen plate width	mm	610
Screen plate thickness	mm	16

Each screen plate is having 10 nos. of aperture having length 850 mm*25mm
Total No. of Deck plate - 4
Total No. of Screen plate -16
TABLE -II

Components material properties	
Material	St 42
Poisson's ratio (v)	0.3
Young's modulus (E)	210000 MPa
Density (ρ)	7850 kg/m^3
Yield stress (Sys)	250 MPa
Ultimate Tensile stress (Sut)	500 MPa
Elongation (%)	23%

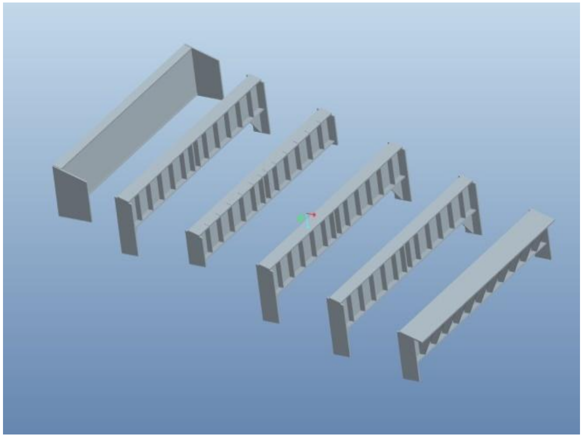


Fig 4.1 Model of Beam assembly in vibrating grizzly feeder

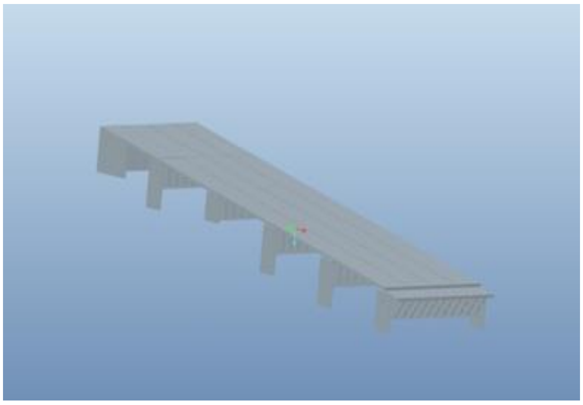


Fig 4.2 Vibrating Grizzly Feeder assembly including plates

V. MODAL ANALYSIS OF VGF BASED ON ANSYS 14

Modal Analysis is done to find natural frequency and modes of the system. ANSYS 14 Workbench provides better solution for Modal Analysis. Model created in Pro-E is browsed to ANSYS Environment.VGF is given constrain as shown in below fig 3. Side plates of each beam having blue colour indicate fixed support. The whole structure is fixed by sides not by bottom as actual configuration.

We Mesh the whole VGF very finely, especially the screen area by 15 mm elemental size for meshing. We generated 771299 nodes representing 187 bodies' active components. Total elements created are 116174.

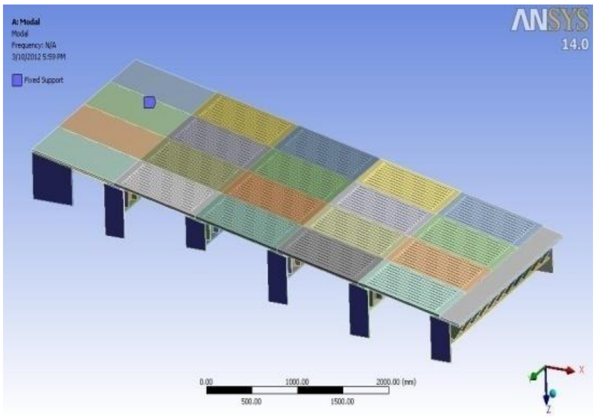


Fig.5.1 Model showing constrains (Blue colour represents fixed support)

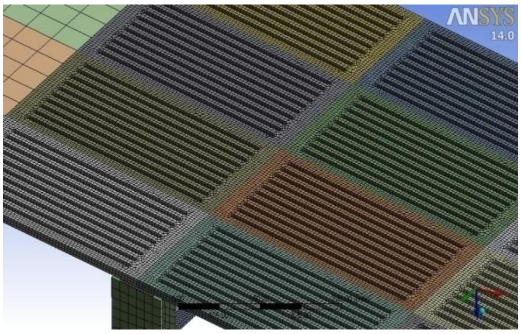


Fig.5.2 Generation of fine mashing

Material properties for St-42 are applied as table-2. We have done solution on ANSYS to find 10 natural frequencies (Modes).

VI. RESULT OF MODAL ANALYSIS

MODAL ANALYSIS

ANSYS gave us result by finding 10 natural frequencies. These natural frequencies are give in table-4.

`	Mode	Frequency[Hz]
1	1	132.06
2	2	136.97
3	3	141.22
4	4	148.06
5	5	159.86
6	6	171.35
7	7	176.09
8	8	181.58
9	9	182.18
10	10	183.67

First mode comes at 132.06 Hz. We have to compare it with working frequency of a system, which is 25 Hz. This indicates there "Resonance" will not occur.

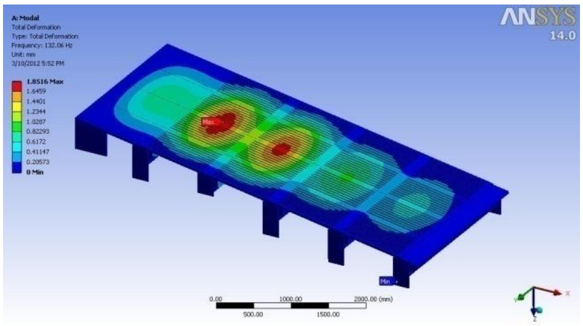


Fig 6.1 First modal frequency (132.06 Hz)

VII. GRAVITY LOADING

Same boundary conditions were given as Modal analysis and same meshing was done on VGF. In first loading condition we had taken only gravity load, deformation and Von-Mises stress were found out.

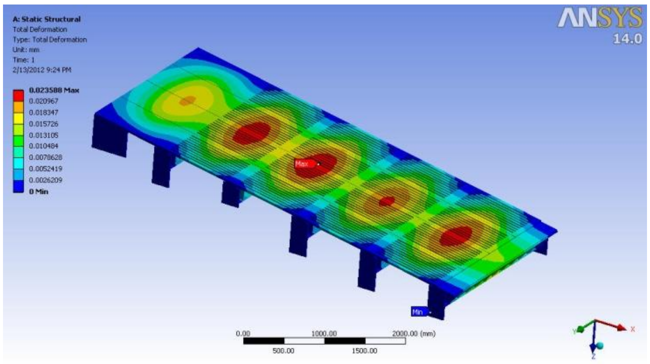


Fig 7.1 Total deformation

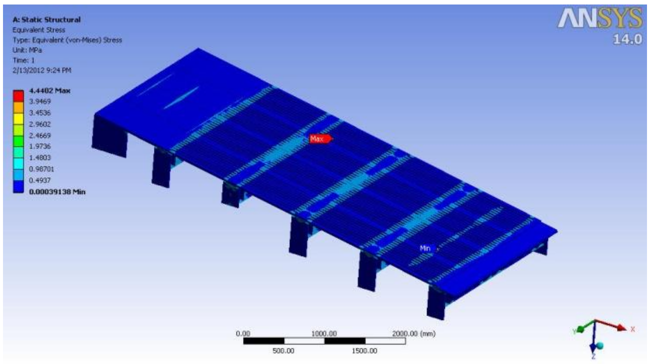


Fig 7.2 Von-Mises stress

VIII. MATERIAL FALLING DIRECTLY ON DECK

Same boundary condition as above both cases was given. It was assumed that material falling is having 25% oversized particles. 1500 TPH means 416kg material falling per second. Material is directly falling from hopper on deck plate of VGF. In this case two conditions were taken (i) Hopper is directly above four deck plates (ii) Hopper is directly above middle two deck pates.

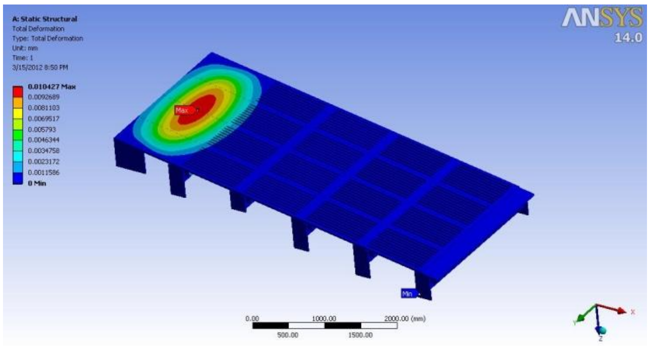


Fig 8.1 Total deformation [case(i)]

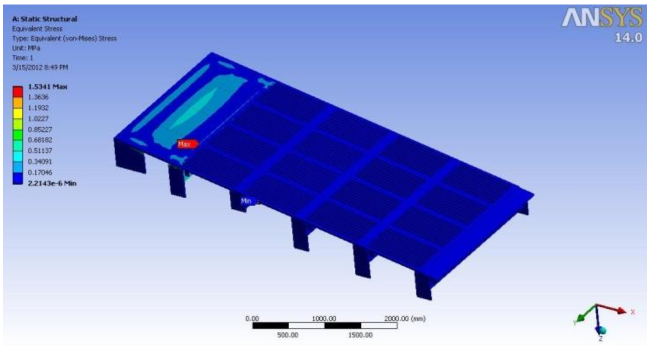


Fig 8.2 Von-Mises stress [case(i)]

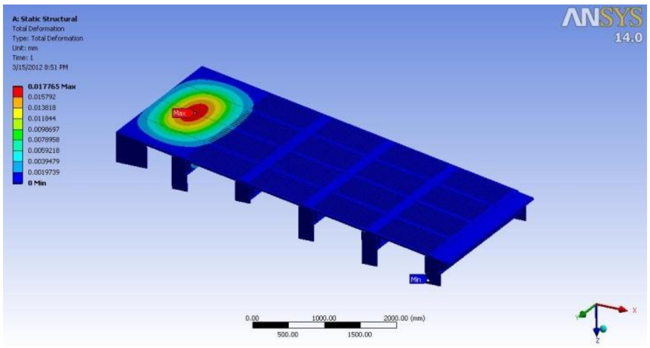


Fig 8.3 Total deformation [case (ii)]

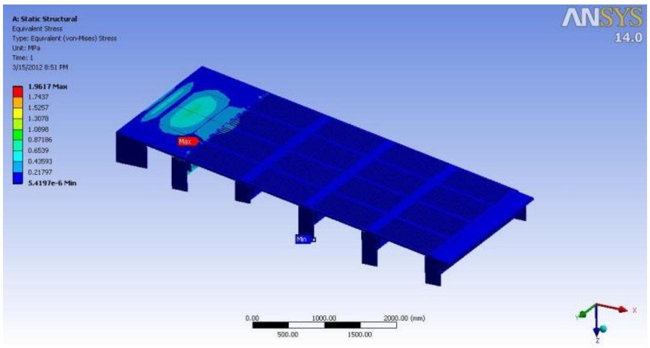


Fig 8.4 Von-Mises stress [case(ii)]

IX. RESULT AND DISCUSSION

First the Factor of Safety is assumed as 3, by previous experience by ELECON. Design is based on yield stress, so the allowable stress is 83.33 MPa, if the value of Von-Mises stress comes below this in all cases then design will be safe.

(1) Gravity loading-
Von Mises stress- 4.44 MPa
Total deformation- 0.0235mm

(2) Material direct fall
(i) On all four deck plate
Von Mises stress- 1.53 MPa
Total deformation- 0.010 mm
(ii)On middle two decks
Von Mises stress- 1.96 MPa
Total deformation- 0.0157 mm

From above both cases it is found that working stress is less than allowable stress so machine will not deform under this loading conditions.

X. CONCLUTION

Using the Pro-Engineer and ANSYS for the design and finite element analysis, the designer can easily modify and analyze the approved drawing. As in the case of VGF natural frequency of the system is very much important, if we go to find it with theoretical methods it will take too much time and calculations. But by using ANSYS we can easily calculate natural frequency of the system and can find number of natural frequencies (modes). This will help us to design the system to avoid “Resonance”. Also applying different loading conditions we can find behavior of VGF under such loading. Further more loading conditions can be check out.

XI. ACKNOWLEDGEMENT

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It is a great pleasure for me to express my thanks and heartiest gratitude to all those who have helped me during the development of this project. I would like to take opportunity to thank all of them.

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There is no doubt that in spite of my best efforts, some errors might remain. I will be grateful, if they could communicate to me any errors they discovered

REFERENCES

[1]. A. H. Redford and Cl. Boothroyd, Vibratory feeding. Proc. Inst. Mech. Eng. 182(6),pp 135-146 (1968)

[2]. G. Boothroyd, C. Poli and L. E. Murch, Automatic Assembly. Dekker, New York (1982).

[3]. D. K. Reynolds, Evaluation and selection of feeding equipment for bulk materials. Bulk Solids Handling 3(4), pp735-740 (1983).

[4]. K. W. Lonie, A practical model for sub-resonant vibratory feeders. Bulk Solids Handling 3(4),pp 741-746 (1983).

[5]. S. A. MacDonald and B. J. Stone, An investigation of vibratory feeders. In: Proc. Int. Conf. of Noise and Vibration ‘89, Singapore, Cl2-C26 (1989).

[6]. G. H. Lim, On the conveying velocity of vibratory feeder. Pergamon.pp197-203 (1995).

[7]. R. T. FOWLER and S. C. LIM “The influence of various factors upon the effectiveness of separation of a finely divided solid by a vibrating screen” Chemical Engineering Science,1959 Vol-10.pp-163-170

[8]. M.A.Parameswaran and S. Ganapathy “Vibratory Conveying-Analysis and Design: A Review” Mechanism and Machine Theory. Vol 14, pp.89-97

[9]. G. H. Lim “Vibratory feeder motion study using Turbo C++ language” Advances in engineering software, (18),1993 pp.53-59