Study and Analysis of Deck inclination angle on Efficiency of Vibration Screen

Gunaji Ashok Sawant[1] V. Murali Mohan[2] Sandip Ashok Sawant[3]
Finolex Academy of Management and Technology Ratnagiri[1][2],Dhole patil College of Engineering wagholi,pune[3]

***Abstract* - In this paper, we simulated the Screen deck inclination and its effect on screening efficiency of a linear vibrating screen using the Discrete Element Method (DEM). The simulation carried out on Bulk flow Analysis Software. Vibration screen efficiency affected by different factors such as screen deck inclination, mesh size of screen, Amplitude of vibration, feed rate of material etc. In this study we considered effect of deck slope inclination on screening efficiency of vibration screen. The screen considered for study work is vibratory screen handling granular dry solid material. Simulation carried out on Bulk Flow Analysis software which give flow of particle on vibratory screen as well particle velocity at different time interval. The output particle amount is calculated and relation between efficiency and screen inclination angle is plotted. It is found that screening efficiency increases with increase in screen deck slope.**

***Keywords* - DEM, Vibration Screen, Inclination, Efficiency, Granular flow**

I. INTRODUCTION

Sieving is one of the oldest and most extensively employed physical size separation techniques. Although the method may be dated back to thousands of years ago, an insightful understanding about this has never been realized up to present [1]. As the mainstream of screening machine, vibrating screens were widely used on iron ore and coal whose separation capacity depends on the development of theoretical screening technology. The complexity lies in the particle size distribution and industrial solid composition, as well as the interaction between particles and machines. As a result, effective analytical and experimental techniques are needy to study the particulate systems [2]. Specifically, a mathematical model needs to be proposed, which describes the parameters concerning the screening efficiency to the design and manufacture vibrating screen. Some earlier models based on reaction kinetic theories and probability theories have been presented for batched and continuous sieving [3] put forward movement forms of a single particle on the sieve surface: relative static, relative sliding and the projectile motion, respectively. However, these theories failed to account for the interaction between particles [4]. Probability and statistics theories were also used to approach the problem. The mathematic model of penetration probability along the screen was set forth by using the method of probability.[5] performed DEM modeling of linear vibration screen to analyze the relationship between screening efficiency and vibration parameters. Besides, the screening process of banana screens was simulated using DEM [6]. The implementation of DEM for screening process gives an insight to study the particulate systems. More attractive methods were realized by incorporating DEM and other techniques. For instance, the coupled DEM and SPH (smoothed particle hydrodynamics) method is used to predict the motion of the solid particles and fluid flows by[7]. A two-step coupling method by joined the output of DEM simulation with Finite Element Method (FEM), and then conducted parametric study of shot peening. In addition, using positron emission particle tracking (PEPT) and DEM, the granular flow was investigated [7] investigated the effect of design parameter on screening performance of screen using LIGGGHTS DEM solver.

II. METHODOLOGY

1.Dem Modeling

Dem modeling consist of making surface model in modeling software with its geometric properties. According to selection of angle of inclination for simulation different angles given to the system.
Properties of system as:
Length of vibrating screen model: 1000mm
Width of vibrating screen model: 500mm
Sieve mesh size: 30mm*30mm
Type of material: granular dry solid particle

2. DEM Simulation steps

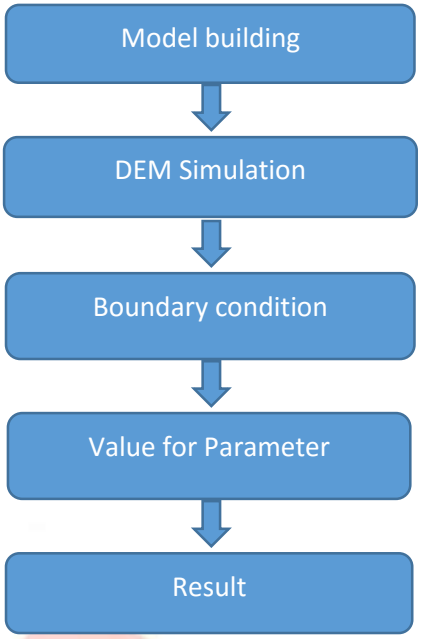

Fig.2 Flow chart for DEM simulation flow

Discrete element method (DEM), also called a distinct element method, is any of a family of numerical methods for computing the motion and effect of a large number of small particles. Though DEM is very closely related to molecular dynamics, the method is generally distinguished by its inclusion of rotational degrees-of-freedom as well as stateful contact and often complicated geometries (including polyhedra). With advances in computing power and numerical algorithms for nearest neighbor sorting, it has become possible to numerically simulate millions of particles on a single processor. Today DEM is becoming widely accepted as an effective method of addressing engineering problems in granular and discontinuous materials, especially in granular flows, powder mechanics, and rock mechanics. Discrete element methods are relatively computationally intensive, which limits either the length of a simulation or the number of particles. Several DEM codes, as do molecular dynamics codes, take advantage of parallel processing capabilities (shared or distributed systems) to scale up the number of particles or length of the simulation. An alternative to treating all particles separately is to average the physics across many particles and thereby treat the material as a

Screen inclination (degree)	Material feed rate(TPH)	Vibration frequency	Vibration amplitude
20	1.5	20	5
21	1.5	20	5
22	1.5	20	5
23	1.5	20	5
24	1.5	20	5
25	1.5	20	5
26	1.5	20	5
27	1.5	20	5
28	1.5	20	5
29	1.5	20	5
30	1.5	20	5

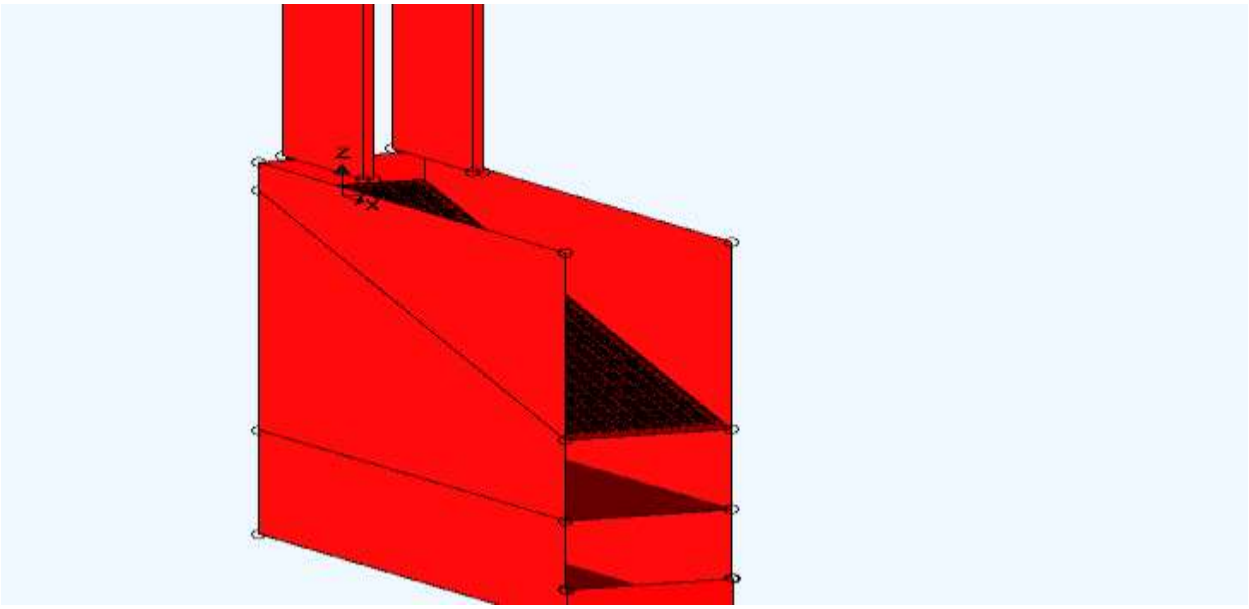

Fig.1 DEM Model of vibration screen

continuum. In the case of solid-like granular behavior as in soil mechanics, the continuum approach usually treats the material as elastic or elasto-plastic and models it with the finite element method or a mesh free method. In the case of liquid-like or gas-like granular flow, the continuum approach may treat the material as a fluid and use computational fluid dynamics. Drawbacks to homogenization of the granular scale physics, however, are well-documented and should be considered carefully before attempting to use a continuum approach.

III. RESULT

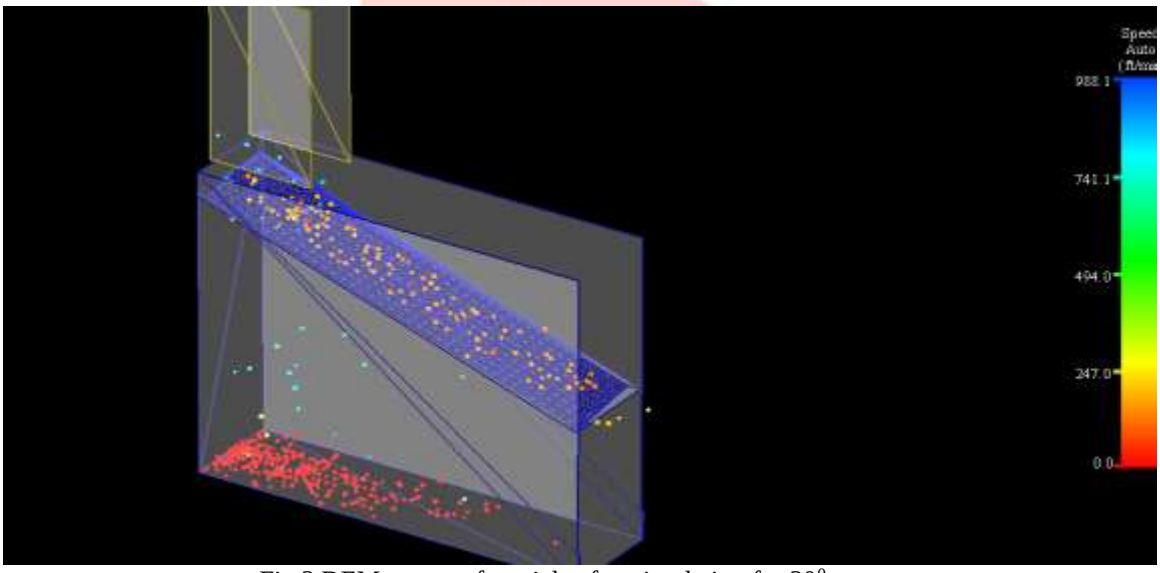

Fig.3 DEM output of particle after simulation for 30^0 screen

From fig.4 it is shown that velocity of particle in x, y and z direction shows uneven distribution. Velocity of particle on screen effect rate of particle travel on screening surface. Velocity of particle at different position of screen surface changes due to bouncing motion getting from screen surface.

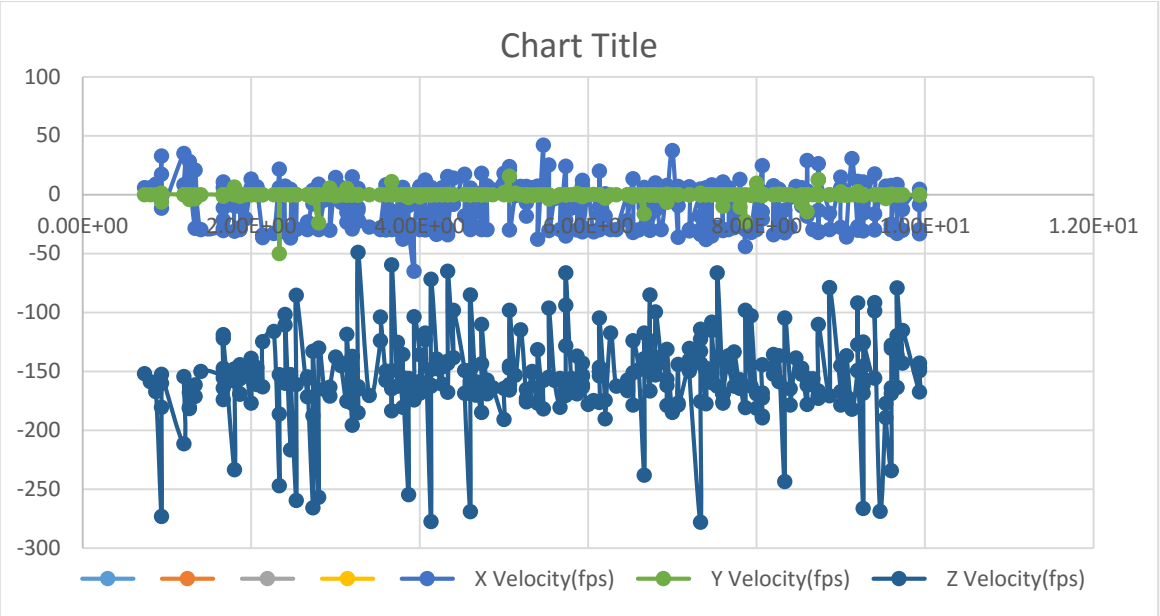

Fig.4 for 30^0 angle relation between velocity in x,y and z direction with respect to time

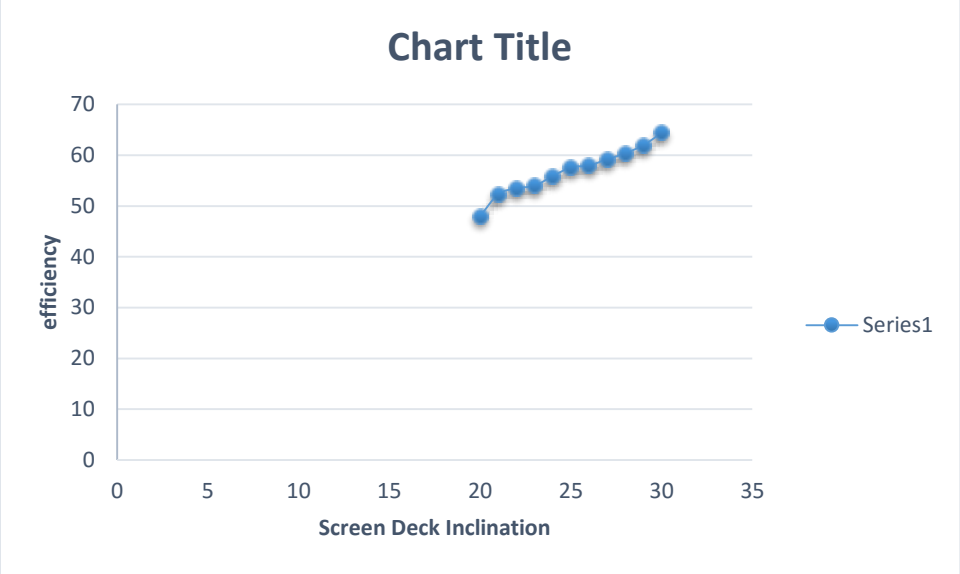

Fig.5 Relation between efficiency and screen deck inclination.

Screening efficiency of vibration screen increases with increase in screen deck inclination. Screen deck inclination performs important role in getting efficiency of vibration screen. With increase in deck slope particle travel rate on vibration screen get accelerated due to this particles have more time to pass on vibration screen surface.More number of particles touches to the vibrating screen surface this result in stratification of material at higher rate.

IV. REFERENCES

1. Changlong Du,Kuidong Gao,Jiamping Li and Hao Jiang, "Dynamics Behavior Research on Variable Linear Vibration Screen with Flexible Screen Face", Advances in Mechanical Engineering Volume 2014,pp.412-424.
2. He Zhao Xia,Liuking-Tao,ChangLi-Hao, "Dynamics Analysis and Experiment of Vibrating Screen for Asphalt Mixing Equipment", journal of sensor and transducer, volume 169,pp.205-210
3. Zerong Zhang,Yongyan Wang and Zhimin Fan, "Similarity Analysis between Scale Model and Prototype of Large Vibrating Screen", journal of Shock and Vibration Volume 2015, pp.331-338
4. HE Xio-mei,LIU Chung-Sheng, "Dynamics and screening characteristics of a vibrating screen with variable elliptical trace",journal of Mining Science and Technology 2009,pp. 0508–0513.
5. N. Rotich , R. Tuunila, M. Louhi-Kultanen, "Empirical study on the effects of screen inclination and feed loading on size classification of solids by gravity", Journal of mineral engineering 2015, pp.162-169.
6. Zhao Lala, Zhao Yuemin, Liu Chusheng, Li Jun, Dong Hailin, "Simulation of the screening process on a circularly vibrating screen using 3D-DEM",Joural of mineral engineering 2011,pp. 677-680.
7. M. Jahani, A. Farzanegan , M. Noaparast, "performance of Banana screen using LIGGGHTS DEM solver", International Journal of Mining Science and Technology 2015, pp.32-57.

8. Leonid I. Slepyan, Victor I. Slepyan, **"**coupled mode parametric resonance in vibrating screen**"** Mechanical Systems and Signal Processing 2014, pp.295-304.
9. Zhanfu Li, Xin Tong ⇑, Bi Zhou, Xiaoyue WangModeling and parametric optimization of vibration screen, Journal of mineral Engineering2015,pp149-155