

Study of Kinematic and Dynamic Analysis of Jaw Crusher - A Review

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Abstract— Jaw crushers are uses compressive force to break particles through its crusher plates (Ni-Cr Alloyed Cast Iron), which are working with the help of kinematic mechanism. In the crusher machine a metallic plate is attached to compress or break the materials by primary, secondary crushers handling course materials, tertiary and quaternary crushers reducing ore particles to finer gradations, i.e. stones, dolomites. Jaw crushers are probably easily recognized crusher in size reduction operation. The reduction ratio of jaw crusher is 3:1 to 5:1. This paper focuses on review of a work done by researchers in the field of kinematic and dynamic analysis of jaw crusher attachments. Kinematic and dynamic analysis is very useful to understand and improve the quality of jaw crushers.

Keywords–Jaw crusher, Kinematic analysis, Dynamic analysis.

I. Introduction

Jaw crusher generally consist of a heavy duty steel plate, fitted with a fixed vertical crushing “jaw” at one end a moving “jaw” opposite it, with a method of transferring motion to moving jaw. The moving jaw swings towards and away from the fixed jaw, creating compression on the rock. The opening between the fixed and moving jaw tapers vertically from wide at the top to narrow at the bottom, thus gradually the size of rock reduces as it moves down through the “crushing chamber”. The movement of jaw is very small, since complete crushing is not performed in one stroke. The required inertia to compress the material is covered by flywheel that moves the shaft and creating an eccentric motion. The jaw plates can be flat, corrugated and ribbed or a combination of these. The single and double toggle jaw crushers are constructed for heavy duty fabricated plates with reinforcing ribs throughout. Fixed and movable jaw faces are made up of manganese steel. The working principle of jaw crusher shown below in Figure 1 and the single and double toggle jaw crusher mechanism is shown in Figure 2 and Figure 3.

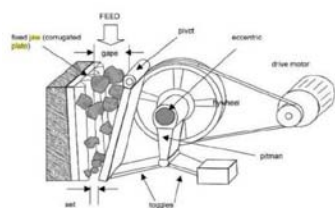


Fig.1 Working Principle of Jaw Crusher

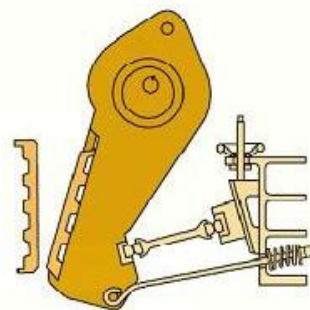


Fig.2 Single Toggle Jaw Crusher

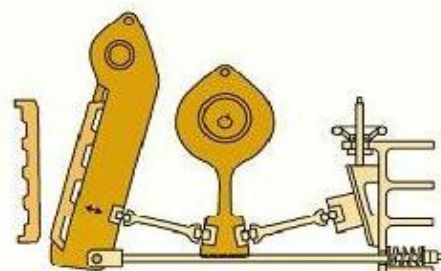


Fig.3 Double Toggle Jaw Crusher

II. FORMULATION OF PROBLEM

The reduction of size of object is basically converting in to the higher order dimension to the lower order dimension by

using kinematic mechanism. The problem identified is the energy consumed by the crusher is in the huge amount, so this can be overcome by study and analysis of kinematics and dynamics of jaw crusher mechanism.

2. Kinematic And Dynamic Analysis

Efforts to decrease energy consumed in crushing have result in consideration of decreasing the load of the swing plate of jaw crushers for simply crushed material. This paper delineated by CHARLES H. DONDING, in 1981, Department of engineering, North Western University, Evanston, IL (U.S.A.) the results of the investigation of the practicability of exploitation point load deformation failure in conjunction with interactive failure of rock particles as a model for such a weight reduction PDF relationships were determined by “Point Load Deformation Relationships and style of jaw crusher plates” point loading.

Various sizes of materials: Mortar.
A numerical model had to be developed.

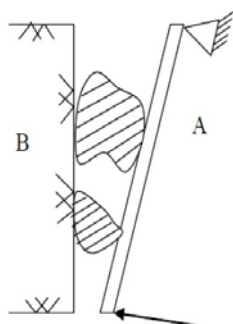


Fig.4 Idealized View

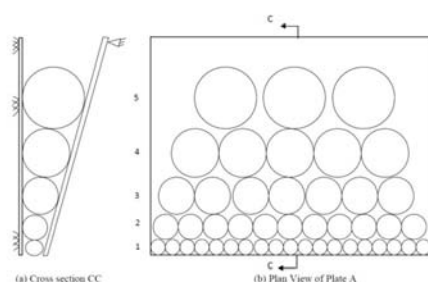


Fig.5 Plan and Cross Section View

In this study point loading of cylinders (or discs) was undertaken to model behavior of irregular stones. Modeling irregular particle behavior thereupon of cylinders are often acceptable by thought of work conferred by Hamamatsu and Oka from photograph elastic studies of plate-loaded spheres and point loaded cubes, ellipsoids and prisms, they determined that the stresses induced in plate and point-loaded spheres of identical diameter were equal. therefore the plate idealization is also replaced by the purpose load shown in fig. 6. They additionally showed that point-load failure of a sphere was up to that of a point-loaded ellipsoid. Therefore, ultimate point loads on sphere are or so up to ultimate point loads on cylinders (or discs). For each the

ellipsoids and therefore the cylinders, the excess volume outside the spherical dimensions does not change the circular failure surface parallel to the smallest dimensions of the body. Hiramatsu and Oka's photo-elastic studies and theoretical calculations reveal that point loads produce tensile stresses across the middle 70% of the axis between the point loads.

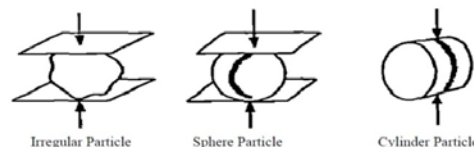


Fig.6 Comparison of plate point loaded particles

The interactive model of rock and swing plate deformation shows a calculated reduction in both swing plate mass maximum toggle force compared to the no interactive assumption of simultaneous failure. This theretical reduction indicates that design of new energy efficient system should include deformation properties of the crushed material.

The product size distribution is obtained as perform of the crusher's rotor radius and angular velocity, the feed rate and therefore the feed size distribution. The model is based on the quality matrix formulation that features classification and breakage matrices. It are often applied to each hammer and vertical-axis impact crushers with the assistance of the corresponding estimations for the impact energy per unit mass. Here we have a tendency to propose classification and breakage functions for impact crushers taking under consideration the dynamic character of the impact breakage. The classification perform has the shape of a additive Weibull distribution incorporates a minimum breakable size of the particles reckoning on the impact energy and therefore the feed rate. The breakage perform is sculptural because the total of 2 Broadbent–Callcott distributions. it is assumed to depend upon the impact energy and therefore the feed rate through the planned expression for the proportion of the fine fraction within the product describes “A performance model for impact crushers” by. S. Nikolov 2002. The model predictions square measure compared with experimental knowledge for stone treated in an exceedingly pilot-plant hammer crusher. The variations of the product size distribution ensuing from changes within the rotor velocity and therefore the feed rate square measure investigated.

S. Nikolov, in “Modeling and simulation of particle breakage in impact crushers” Centre Terre et pierre, 55 Che'e “Antoing, Tournai, in 2004 worked a phenomenological model that predicts the dimensions distribution of the product issued from impact crushing in perform of the rotor strike radius and speed, the material properties and size distribution of the feed moreover because the feed rate. The model relies on the standard matrix illustration moreover as classification and breakage matrices. It will be applied to each horizontal-shaft crushers, the HSI (Horizontal Shaft Impactor) break rock by impacting the rock with hammers that are mounted upon the periphery of a spinning rotor. HSI machines are sold-out in Stationary, trailer mounted and crawler mounted

configurations. HSI's are utilized in utilization, laborious rock and soft materials. In earlier years the sensible use of HSI crushers is proscribed to soft materials and non abrasive materials, like limestone, phosphate, gypsum, weathered shales, however enhancements in metallurgy has modified the applying of those machines and and vertical-shaft crushers, the VSI (Vertical Shaft Impactor) use a special approach involving a high speed rotor with wear resistant tips and a crushing chamber designed to 'throw' the rock against. The VSI crushers utilize speed instead of surface force as the predominant force to break rock. In its state of nature, rock features a jagged and uneven surface. Applying surface force (pressure) results in unpredictable and generally non-cubical resulting particles. VSI crushers usually utilize a high speed spinning rotor at the center of the crushing chamber and an outer impact surface of either abrasive resistant metal anvils or gravel. crushers by means of the corresponding estimations for the typical impact energy per unit mass presented here. we propose a brand new classification function for impact crushers in the form of a Weibull cumulative distribution. The minimum size of the particles that bear breakage is assumed to be a function of the impact energy and therefore the feed rate. The model predictions are compared with experimental information obtained for rock treated in an exceedingly pilot-plant hammer crusher. The dependence of the product size distribution on the rotor speed is investigated. The influence of the feed rate on the product size is additionally simulated. Feed rate graph is shown figure 7.

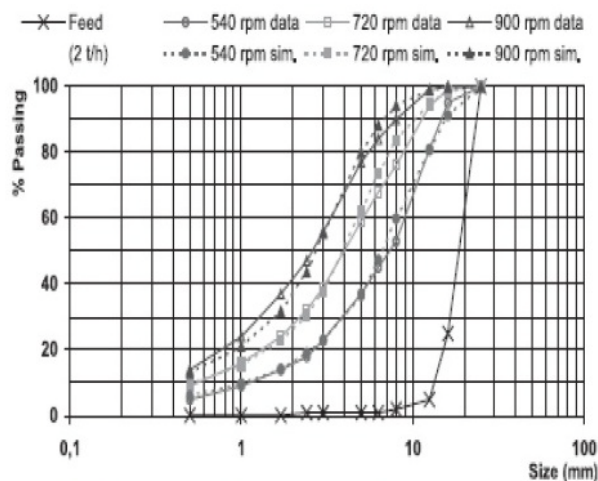


Fig.7 Experimental and simulated product size distributions at different rotor velocities for feed rate $Q=2$ t/h.

CAO Jinxi, RONG Xingfu, yang Shichun, in 2006[4] have developed Jaw Plate Kinematical Analysis For Single toggle Jaw crusher design, school of technology, taiyuan University of Technology, Taiyuan, China. Jaw crusher could be a quite size reduction machine that is wide used within the mining and aggregates trade. The interaction between jaw plates and material particles brings the inevitable and serious wear to the jaw plates throughout the jaw device operation, that not solely decreases the potency, but additionally will increase the worth and additionally the energy consumption of the jaw device. The breakage force is tested among the experiment and many data on the particles flow is gained by analyzing the force distribution. supported the movement analysis of the moving jaw and additionally the crushing force distribution analysis, the jaw plates wear is analyzed on a gross level. The results of the wear and tear

analysis can justify variety of the event in observe. With the rock material breakage character taken into thought, the visual defect brought by the quality empirical planning are typically greatly decreased . it's helpful to style the crusher for improved performance. Jaw crusher structure diagram shown in figure 8.

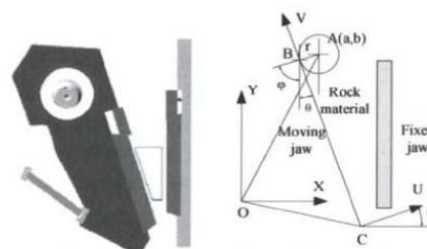


Fig.8 Single toggle jaw crusher & jaw crusher structure

The breakage force is measured at intervals the experiment and many new knowledge on the material flow in jaw crusher chamber is illustrated with the particle breakage character taken into thought. supported the movement analyses of the moving jaw and so the crushing force distribution analysis, the jaw plates wear is analyzed. the link between the slide and so the damage is cheap and many results of the damage analysis area unit valid in observe. Predicting the jaw plates wane an oversized level are helpful to the jaw crusher style for higher performance. Since the slide between the particles and so the jaw plates is replace by the vertical movement distance of the moving jaw plate throughout this paper, the extra study is needed to predict the right wear rate.

The performance of jaw crusher is particularly determined by the kinetic characteristic of the liner throughout the crushing methodology. the sensible kinetic characteristic of the liners that are placed in bound domain of the coupling plane are computed and mentioned inside the paper titled “Investigation on Kinetic features of Multi-Liners in coupling Plane of Single Toggle Jaw Crusher” by Cao Jinxi, Qin Zhiyu, Wang Guopeng, Rong Xingfu, yang Shichun 2007, IEEE, faculty of coupling, metropolis University of Technology, Taiyuan. supported those computing results and analysis for the points chosen from the liners paralleling coupling plane, distinctive Swing options and mechanics arguments are determined so as to create the kinetic characteristic arguments. the work is helpful for a design of recent image of this sort of machine on optimizing the frame, designing the chamber and recognizing the Crushing character. Kinetic characteristic of the crushing interface or the liner. supported the computation and thus the analysis of the sensible kinetic characteristic of the points inside the liner domain, some ancient motion parameters and a couple of kinetic arguments are calculated. in line with the necessity for the compression motion of varied zone inside the crushing chamber, the chamber pure mathematics are often improved.

Now use Pro/Engineer is also a relentless amount feature-based design of 3D software system package, with constant quantity modeling functions. to reduce the event cycle and improve the look quality of jaw crusher, this paper mentioned by Yuming guan, Zhitao Zhang, Qianwei Zhang, hebei University Of Technology Hebut tianjin, China 2011, IEEE, ”Modeling simulation and Kinematic analysis base on Pro/Engineer for Jaw crusher mechanism” takes full advantage of the perform module of the Pro/Engineer platform to make model simulation and dynamic analysis on the particular jaw device mechanism, and provided the updated path for the look and manufacture of Jaw crusher.

The appropriate level of interference detection is chosen in step with the necessity of motion simulation and collision detection of the system is carried in step with the settings. The model are going to be shown in figure 9.

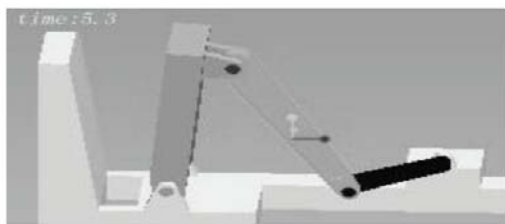


Fig.9 The complete virtual assembly chart of jaw crusher

The higher than module, defines many things, i.e. relative forces, reaction force, impulse, vibrations and positions, static loads of various positions also can be outlined to hold out static analysis, mechanics analysis and dynamic analysis. These are the essential significance for the lifetime of the precise elements. Specific method are not introduced. The dynamic analysis diagram as shown below in figure 10.

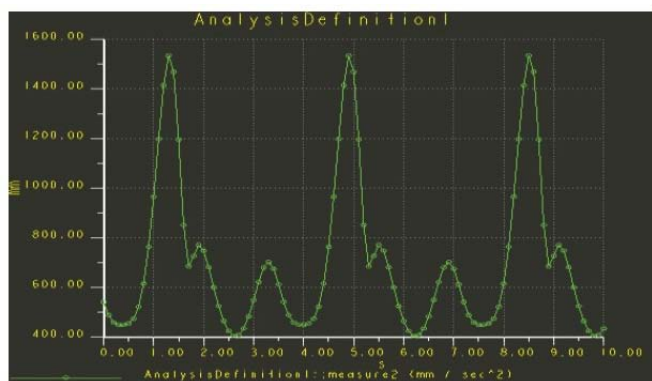


Fig.10 The output image of the acceleration

Through the appliance Pro/E platform on the jaw crusher, not entirely the results of the assembly are going to be expressed at intervals the type of animation, but also can be see output at intervals the type of parameters. Thus, it's straightforward to understand that whether or not or to not give interference between the weather. It makes the initial motion relationships at intervals the 2d view are difficult to be expressed become intuitive and easy to vary. At constant time, the event cycle of the jaw device are going to be shortened and thus the planning technique of the mechanism are going to be simplified. And it is a crucial implies that of the stylish product design.

IV. CONCLUSION

Kinematic analysis is useful to know and improve the in operation performance of the particle size reduction. mechanics and dynamic analysis have vital significance for the lifetime of the precise elements. Specific method are going to be now not introduced. this idea of mechanics is followed by variety of researches for his or her application. This review provides the background of Jaw crusher mechanics to carried out more analysis add same area.

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