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"A STUDY ON CONSTRUCTION TECHNOLOGY MACHINE JAW CRUSHER "

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ABSTRACT

Civil Construction machine crushers are one of the major size reduction equipment that is used in metallurgical, mechanical, and other similar industries. They exist in various sizes and capacities which range from 0.1 ton/hr. to 50 ton/hr. They can be classified based on the degree to which they can fragment the starting material and the way they apply forces. Based on the mechanism used crushers are basically of three types namely Cone crusher, Jaw crusher and Impact crusher. Our objective is to design various components of an Impact crusher like drive mechanism, shaft, rotor, hammers, casing, and discharge mechanism which will be useful in minimizing weight, cost and maximizing the capacity and also do their analysis. Impact crushers involve the use of impact rather than pressure to crush materials. Here the material is held within a cage, with openings of the desired size at the bottom, end or at sides to allow crushed material to escape through them. This type of crusher is generally used with soft materials like coal, seeds or soft metallic ores. The mechanism applied here is of Impact loading where the time of application of force is less than the natural frequency of vibration of the body. Since the hammers/blow bars are rotating at a very high speed, the time for which the particles come in contact with the hammers is very small, hence here impact loading is applied. The shaft is considered to be subjected to torsion and bending. The grinding screen is also designed for optimal output from the crusher. A Performance model is also considered for the horizontal shaft impact crusher so as to find out the relation between the feed, the crusher parameters and the output parameters. Pro/Engineer is a parametric feature-based design of 3D software and capable to solve the motion dynamics of the motion, and the reactions at the constraints of the mechanisms can be used as the inputs for any Finite element program to understand the behavior of stresses and deformations of the individual component of the machine to estimate the working life of the machine elements designed for the application. Parametric modeling functions. To reduce the development cycle and improve the design quality of jaw crusher. The Pro/Engineer platform to make model simulation and dynamic analysis on the actual jaw crusher mechanism, and provided the updated path for the design and manufacture of Jaw Crusher.Pro/Engineer is a parametric feature-based design of 3D software, with parametric model functions Finite Element Analysis (FEA) is the powerful technique in strength calculations of the structures working under known load and boundary conditions. In general, computer aided drawing model of the parts to be analyzed must be prepared prior to the FEA. This paper provides the platform to understand the Modeling, FEA of Jaw crusher swing jaw plate attachment, which was already carried out by other researchers for their related applications and it can be helpful for development of new jaw crusher's attachments.

Key Words: *Civil Construction machine, crushers, 3D software , cost.*

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I. INTRODUCTION

Jaw crushers are major size reduction machines, which is used in civil construction work also and allied industries. Crushing is the process of reducing the size of solid particles into definite smaller sizes. The crusher crushes the feed by some moving units against a stationary unit or against another moving unit by the applied pressure, impact, and shearing or combine action on them. They are available in various sizes and capacities ranging from 0.3 ton/hr to 50 ton/hr. They are classified based on different factors like product size and mechanism used. Based on the mechanism used crushers are of three types namely Cone crusher, Jaw crusher and Impact crusher.

Fracture occurs in the feed material when the strain developed in it due to sufficiently applied impact forces, pressure or shearing effect exceeds the elastic limit .Generally crushers are very rugged, massive and heavy in design. The contact surfaces are equipped with replaceable liners made from high tensile manganese or other alloy steel sheet having either flat or corrugated surfaces. Shearing pins or nest in heavy coiled springs are provided in the crusher to guard against shock and over load.

A crusher may be considered as primary, secondary or fine crusher depending on the size reduction factor.

Primary crusher – The raw material from mines is processed first in primary crushers.
The input of such crushers is relatively wider and the output products are coarser in size. Example - Jaw crusher, Gyratory crusher.

Secondary crusher- The crushed rocks from primary crusher are sent to secondary crusher for further size reduction.
Example - Cone crusher, reduction gyratory crusher, spring rolls, disk crushers etc.

Fine crushers- Fine crushers have relatively small openings, and are used to crush the feed material into more uniform and finer product.
Example - Gravity stamp.

The material to be crushed is dropped between two rigid pieces of metal, one of which then move inwards towards the rock, and the rock is crushed as it has a lower breaking point than the opposing metal piece. Jaw crusher movement is guided by pivoting one end of the swinging jaw. And an eccentric motion located at the opposite end.

The size of a jaw crusher is designated by the rectangular or square opening at the top of the jaws .For instance, a 22 x 30 jaw crusher has an opening of 22" by 30", a 46 x 46 jaw crusher has a opening of 46" square.

Generally primary jaw crushers have the square opening design, and secondary jaw crushers have rectangular opening design. Jaw crushers are used as primary crushers in a mine or ore processing plant or the first step in the process of reducing rock. They follow “crush using compression” mechanism.

1.2 Different Types of Jaw Crusher:

According to the amplitude of motion of the moving face; Jaw crusher are classified as follows.

A) - **Blake Type Jaw Crusher:**

Blake type jaw crusher, primary crushers in the mineral industry; attains maximum amplitude at the bottom of the crushing jaws as the swinging jaw is hinged at the top of the frame. These crushers are operated by and controlled by a pitman and a toggle. The feed opening is called gape and opening at the discharge end termed as the set. The Blake crushers may have single or double toggles. The toggle is used to guide the moving jaw. The retrieving motion of the jaw from its furthest end of travel is by springs for small crushers or by a pitman for larger crushers. During the reciprocating action, when the swinging jaw moves away from the fixed jaw the broken rock particles slip down and are again caught at the next movement of the pitman and are crushed again to even smaller size. This process continued till the particle sizes becomes smaller than set; the smallest opening at the bottom. For a smooth movement of the moving jaws, heavy flywheels are used.

Blake type jaw crusher may be divided into two types:

(I)- Single toggle type: - A single toggle bar is used in this type of crushers. Comparatively lighter jaw crushers use single toggle as they are cheap. It is shown figure below.

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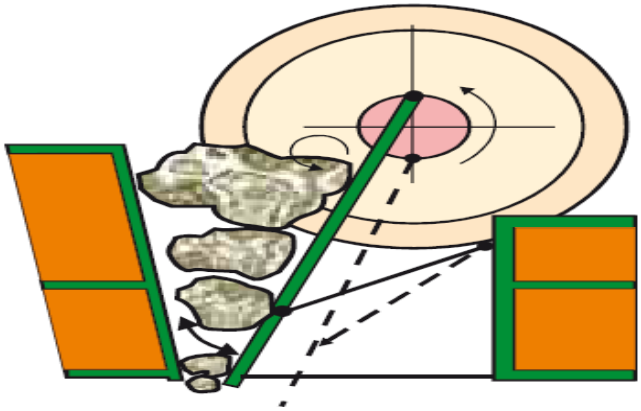

Fig.1: Single toggle jaw crusher

II. LITERATURE REVIEW

A jaw crusher is a kind of size reduction machine which is widely used in mineral, aggregates and metallurgy fields. The performance of jaw crusher is mainly determined by the kinetic characteristic of the liner during the crushing process. The practical kinetic characteristic of the liners which are located in certain domain of the coupler plane are computed and discussed in the paper titled "Investigation on Kinetic Features of Multi-Liners in Coupler Plane of Single Toggle Jaw Crusher" by Cao Jinxi, Qin Zhiyu, Wang Guopeng, Rong Xingfu, Yang Shichun (2007) IEEE College of Civil construction machine Engineering, Taiyuan University of Technology, Taiyuan. Based on those computing results and analysis for the points chosen from the liners paralleling coupler plane, unique Swing features and kinematics arguments are determined in order to build the kinetic characteristic arguments. The job is helpful for a design of new prototype of this kind of machine on optimizing the frame, designing the chamber and recognizing the Crushing character.

The interaction between jaw plates and material particles brings the inevitable and serious wear to the jaw plates during the jaw crusher operation, which not only decreases the efficiency, but also increases the cost and the energy consumption of the jaw crusher. The movement of the moving jaw is described by CAO Jinxi, RONG Xingfu, YANG Shichun College of Civil construction machine Engineering, Taiyuan University of Technology, Taiyuan, China (ITIC) 2006 in their research paper "jaw plate kinematical analysis for single toggle jaw crusher design". The breakage force is tested in the experiment and some information on the particles flow is gained by analyzing the force distribution. Based on the movement analysis of the moving jaw and the crushing force distribution analysis, the jaw plates wear is analyzed on a macroscopic level. The result of the wear analysis can explain by their research paper (ITIC) 2006 some of the phenomenon in practice. With the rock material breakage character taken into consideration, the blindness brought by the traditional empirical designing can be greatly decreased. It is helpful to crusher improved performance.

Now use Pro/Engineer is a parametric feature-based design of 3D software, with parametric modeling functions. To reduce the development cycle and improve the design quality of jaw crusher, this paper discussed 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 Function module of the Pro/Engineer platform to make model simulation and dynamic analysis on the actual jaw crusher mechanism, and provided the updated path for the design and manufacture of Jaw Crusher**.**

In this paper discussed by S. Nikolov, in " Modeling and simulation of particle breakage in impact crushers "Centre Terre et Pierre, 55 Che´e d'Antoing, Tournai, (2004) worked a phenomenological model that predicts the size distribution of the product issued from impact crushing in function of the rotor strike radius and velocity, the material properties and size distribution of the feed as well as the feed rate. The model is based on the standard matrix representation including classification and breakage matrices. It can be applied to both horizontal- and vertical-shaft impact crushers by means of the corresponding estimations for the average impact energy per unit mass presented here. We propose a new classification function for impact crushers in the form of a Weibull cumulative distribution.

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The minimum size of the particles that undergo breakage is assumed to be a function of the impact energy and the feed rate. The model predictions are compared with experimental data obtained for limestone treated in a pilot-plant hammer crusher. The dependence of the product size distribution on the rotor velocity is investigated. The influence of the feed rate on the product size is also simulated.

A model for prediction of sliding wear was suggested by Archard in 1953. Tests have been conducted to determine the "Liner wear of jaw crusher" by M. Lindqvist *, C.M. Evertsson, Machine and Vehicle Systems, Chalmers University of Technology, Goteburg Sweden (2002). Using a small jaw crusher, the wear of the crusher liners has been studied for different settings of the crusher. Crushing forces have been measured, and the motion of the crusher has been tracked along with the wear on the crusher liners. The test results show that the wear mechanisms are different for the fixed and moving liner. If there were no relative sliding distance between rock and liner, Archard_s model would yield no wear. This is not true for rock crushing applications where wear is observed even though there is no macroscopic sliding between the rock material and the liners. For this reason, Archard_s model has been modified to account for the wear induced by the local sliding of particles being crushed. The predicted worn geometry is similar to the real crusher. Wear in rock crushers causes great costs in the mining and aggregates industry. Change of the geometry of the crusher liners is a major reason for these costs. Being able to predict the geometry of a worn crusher will help designing the crusher liners for improved performance A cone crusher is a machine commonly used in the mining and aggregates industry. In a cone crusher, the geometry of the crushing chamber is crucial for performance. The objective of this work, where Jaw crusher wear was studied and implement a model to predict the geometry of a worn cone crusher.

The product size distribution is obtained as a function of the crusher's rotor radius and angular velocity, the feed rate and the feed size distribution. The model is based on the standard matrix formulation that includes classification and breakage matrices. It can be applied to both hammer and vertical-axis impact crushers with the help of the corresponding estimations for the impact energy per unit mass. Here we propose classification and breakage functions for impact crushers taking into account the dynamic character of the impact breakage. The classification function has the form of a cumulative Weibull distribution and incorporates a minimum breakable size of the particles depending on the impact energy and the feed rate. The breakage function is modeled as the sum of two Broadbent–Callcott distributions. It is assumed to depend on the impact energy and the feed rate through the proposed expression for the proportion of the fine fraction in the product describe "A performance model for impact crushers" by . S. Nikolov (2002). The model predictions are compared with experimental data for limestone treated in a pilot-plant hammer crusher. The variations of the product size distribution resulting from changes in the rotor velocity and the feed rate are investigated.

Discrete Element Method (DEM) **"**Discrete element modeling for predicting breakage behavior and fracture energy of a single particle in a jaw crusher**"** technique applied by A. Refahi a J. Aghazadeh Mohandesi b, B. Rezai b (2010). The rocks studied were modeled as granular assemblies located between two jaws, and their fracture mechanism was studied. To verify the obtained results, the spherical and cubic specimens produced from Dokoohak Limestone and Dehbeed Granite were studied and the energy applied by the jaws was compared to those of the fracture energy estimated by the single particle breakage analysis. There is fairly good agreement between the energy acquired from the DEM model and the single particle fracture energy of the spherical rocks. It appears that DEM is a suitable method for predicting the crushing energy of the spherical rocks in the jaw crusher. The fracture behavior of the crushed rocks was examined and compared by the results obtained from the DEM model. The tensile mode of fracture occurring in the spherical rocks is well presented by the discrete element modeling. However, the DEM technique is not capable of modeling the delamination mode occurring in the cubic rocks.

The influence of rock strength properties on Jaw Crusher performance was carried out to determine the effect of rock strength on crushing time and grain size distribution of the rocks Investigation was carried out to determine the effect of rock strength on crushing time and grain size distribution of the rocks. Investigation was conducted on four different rock samples namely marble, dolomite, limestone and granite which were representatively selected from fragmented lumps in quarries. Unconfined Compressive strength and Point load tests were carried out on each rock sample as well as crushing time and size analysis by OLALEYE B M Mining Science and Technology (2010) his paper "Influence of

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rock strength properties on Jaw Crusher performance in granite quarry". The results of the strength parameters of each sample were correlated with the crushing time and the grain size distribution of the rock types. The results of the strength parameters of each sample were correlated with the crushing time and the grain size distribution of the rock types. Show that granite has the highest mean value of 101.67 MPa for Unconfined Compressive Strength (UCS) test, 6.43 MPa for Point Load test while dolomite has the least mean value of 30.56 MPa for UCS test and 0.95 MPa for Point Load test. According to the International Society for Rock Mechanic (ISRM) standard, the granite rock sample maybe classified as having very high strength and dolomite rock sample, low strength. Also, the granite rock has the highest crushing time (21.0 s) and dolomite rock has the least value (5.0 s). Based on the results of the investigation, it was found out that there is a great influence of strength properties on crushing time of rock types.

III. METHODOLOGY

3D Modeling Of Double Toggle Jaw Crusher & Its Kinematic Motion Study With the growth of the computer applications in Engineering, the motion study has become the most important tool these days to solve the problems of kinematics and dynamics of the machines. Nearly every Computer Integrated program is capable to solve the motion dynamics of the motion, and the reactions at the constraints of the mechanisms can be used as the inputs for any Finite element program to understand the behavior of stresses and deformations of the individual component of the machine to estimate the working life of the machine elements designed for the application.
It totally and overall depends upon the user of the software application program, to define the Problem in mathematical form. If the formulation of the problem is not correct, the results can deviate from the actual condition resulting in the failure of the machine component. Thus it is very much advised for the users to predict the results before obtaining the same from the CAD package and verify the same with any simple formulation available in mathematical formulas to gain confidence of the problem definition in the mathematical form.

IV. CONCLUSION

The construction machine is optimized for jaw plate, although the casting cannot be changed with fabrication unit under these stresses. Through the application Pro/E platform on the jaw crusher, not only the result of the assembly can be expressed in the form of animation, but also can be output in the form of parameters. Thus, it is easy to know that whether to produce interference between the parts. It makes the original motion relationships in the 2D view are difficult to be expressed become And it is an important means of the modern product design.

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