

Review Paper on Swing Jaw Plate in Jaw Crusher Machine

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Abstract – Traditionally, stiffness of swing plates has not been varied with changes in rock strength. Rock strength has only been of interest because of the need to know the maximum force exerted by the toggle for energy considerations. Efforts to decrease energy consumed in crushing have lead to consideration of decreasing the weight of the swing plate of jaw crushers for easily crushed material. In the propose work the design of the swing jaw plate using point-load deformation failure relationships along with interactive failure of rock particles as a model for such a reduction in deflection value. Authors were survey different components level research paper and discuss critical review on Jaw Crusher Plate.

Index Terms – Jaw Crusher Plate, Review, Crushing Material, Jaw Crusher Machine.

I. INTRODUCTION

Jaw crusher is a machine designed to reduce large solid particles of raw material into smaller particles. Crushers are major size reduction equipment used in mechanical, metallurgical and allied industries. They are available in various sizes and capacities ranging from 0.2 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.

The first stage of size reduction of hard and large lumps of run-of-mine (ROM) ore is to crush and reduce their size. Large scale crushing operations are generally performed by mechanically operated equipment like jaw crushers, gyratory crusher and roll crushers. For very large ore pieces that are too big for receiving hoppers of mechanically driven crushers, percussion rock breakers or similar tools are used to break them down to size. The mechanism of crushing is either by applying impact force, pressure or a combination of both. The jaw crusher is primarily a compression crusher while the others operate primarily by the application of impact.

II. OVER VIEW OF JAW CRUSHER

The first stage of size reduction of hardand large lumps of run-of-mine (ROM) ore is to crush and reduce their size. Softer ores, like placer deposits of tin, gold, mineral sands etc. do not require such treatment. Large scale crushing operations are generally performed by mechanically operated equipment like jaw crushers, gyratory crusher and roll crushers. For very large ore pieces that are too big for receiving hoppers of mechanically driven crushers, percussion rock breakers or similar tools are used to break them down to size. The mechanism of crushing is either by applying impact force, pressure or a combination of both. The jaw crusher is primarily a compression crusher while the others operate primarily by the application of impact. [11]

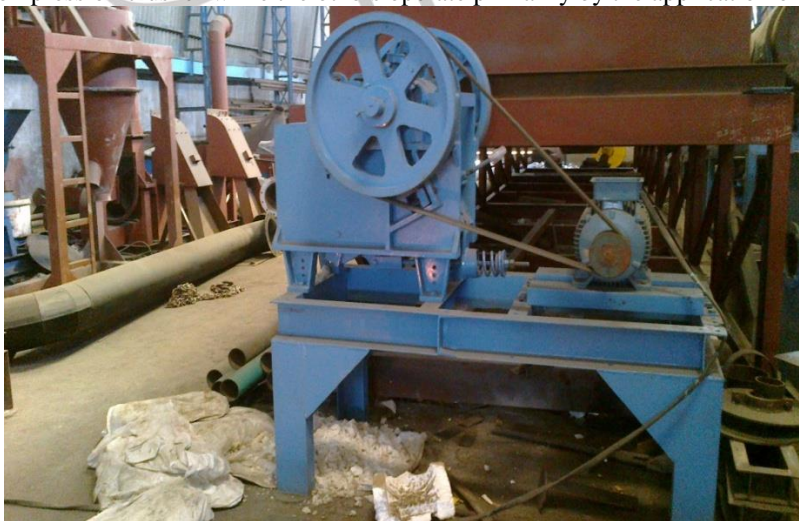


Fig.1 Typical Jaw Crusher [10]

III. DIFFERENT TYPES OF JAW CRUSHER

BLAKE TYPE JAW CRUSHER

In this the movable jaw is hinged at the top of the crusher frame so that the maximum amplitude is obtained at the bottom of the crushing jaws. Blake Crushers are operated by toggles and controlled by a pitman. These are commonly used as primary crushers in the mineral industry. The size of the feed opening is referred to as the gape. The opening at the discharge end of the jaws is referred to as the set. The Blake crushers are single or double toggle drives. The function of the toggle(s) is to move the pivoted jaw. The retrieving action of the jaw from its furthest end of travel is by springs for small crushers or by a pitman for larger crushers. As the reciprocating action removes the moving jaw away from the fixed jaw the broken rock particles slip down, but are again caught at the next movement of the swinging jaw and crushed. This process is repeated until the particle sizes are smaller than the smallest opening between the crusher plates at the bottom of the crusher (the closed set).

For a smooth reciprocating action of the moving jaws, heavy flywheels are used in both types of crushers. Blake type jaw crusher may be divided into two types. [11]

(A) SINGLE TOGGLE TYPE

In this the number of toggle plate is only one. It is cheaper and has less weight compare to a double toggle type jaw crusher. The function of the toggle(s) is to move the pivoted jaw.

(B) DOUBLE TOGGLE TYPE

Here the number of toggle plate is two. Over the years many mines have used the double-toggle style of crusher because of its ability to crush materials, including mineral bearing ores that were both tough and abrasive. While many aggregate producers have used the overhead eccentric style. There are many factors that should be considered when deciding which style would be best for your application.

For larger material crushing, always larger Blake type jaw crushers are selected. The characteristics of this type of crusher are as following

1. Larger, rough, blocky as well as sticky rock or ore lumps can be crushed.
2. Reinforcement of the crusher is possible with the help of high strength crusher frame to crush very hard rock or ore lumps.
3. It is very simple to adjust to prevent much of wear and also very easy to repair,
4. Maintenance of the crusher is very easy.

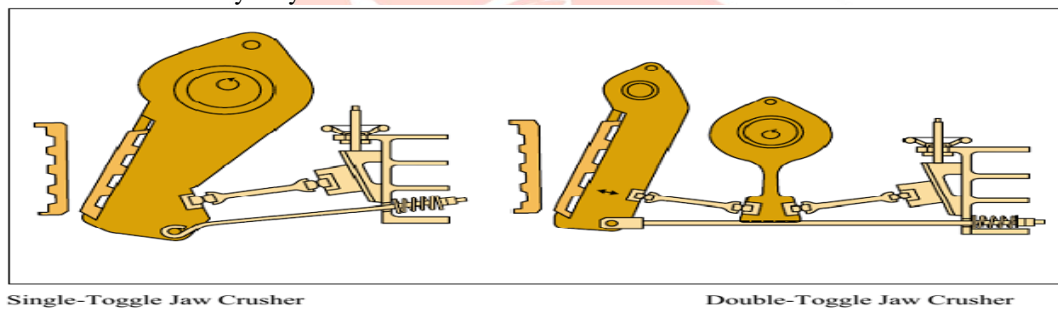


Fig.2 Types of Blake Type Jaw Crusher [13]

DODGE TYPE JAW CRUSHER

The moving plate is pivoted at the bottom and connected to an eccentric shaft. In universal crushers the plates are pivoted in the middle so that both the top and the bottom ends can move. The movable jaw is hinged at the bottom of the crusher frame so that the maximum amplitude of motion is obtained at the top of the crushing jaws. They are comparatively lower in capacity than the Blake crushers and are more commonly used in laboratories.

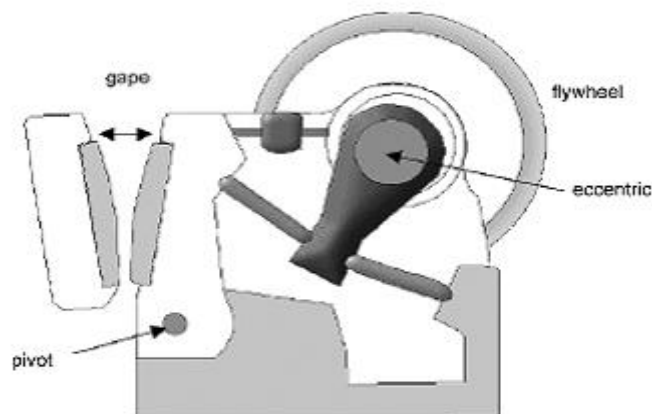


Fig.3 Dodge Type Jaw Crusher [11]

IV. LITERATURE REVIEW

Ramkrushna S. More (2014) [1] had represented, A jaw crusher break minerals, ores of high strength. The stiffness of swing jaw plate has not been varied with changes in rock strength. Thus stiffness of swing plate is enough to crush taconite with an Unconfined compressive strength (QU) of up to 308 MPa, may be over signed for softer fragmental. Hence the weight of the swing plate is necessary to reduced. In this paper work can be done with help of Point-Load Deformation Failure (PDF) relationship Along with interactive failure of rock particles. Design of a plate is carried by using CATIA .And finite element analysis will be carried out by using ANSYS.

Vishal N. Kshirsagar, Dr. S. K. Choudhary, Prof. A. P. Ninawe (2014) [2] had represented Crushers are major size reduction equipment used in mechanical and allied industries which crushes different types of soft and hard materials. The can or bottle crusher machine is widely used in beverage industries or in scrap dealers shop (Bhangarwala) to reduce the volume of the cans/bottles solely to increase the transportation volume and thus to reduce the transportation cost. Hence in this design and analysis of various parts are necessary. This paper focuses on review of a work carried out by researchers on analysis and design of various parts due to which the design quality of that parts will be improved. There are so many researchers who have done work on design and analysis, but still there are so many areas of scope regarding this design and analysis.

Vishal N. Kshirsagar, Dr. S.K Choudhary, Prof. A.P Ninawe (2014) [3] had represented about the design of various components of can or plastic bottle crusher machine. This machine is widely used in beverage industries or in scrap dealers shop to reduce the volume of the cans/bottles. Hence in this design of various parts are necessary, and design of various parts due to which the design quality of those parts will be improved. There are s o many researchers who have done work on design and analysis also, but still there are so many areas of scope regarding this design. Overall, this project involves processes like design, fabrication and assembling of different components etc. After all process has been done, this crusher may help us to understand the fabrication and designing that involved in this project.

Durgesh R. Verma and Pankaj R. Hatwar (2014) [4] had represented Crushers are one of the most important size convertible equipment that is used in coal, mechanical, and other similar industries. They occur in many sizes and capacities which vary from 0.1 ton/hr. to 50 ton/hr. They can be categorized on the mechanism used. Crushers are mainly of three categories i.e. Cone crusher, Jaw crusher and Impact crusher. Our objective is to design numerous mechanisms of an Impact crusher like drive mechanism and discharge mechanism which will be useful in reducing weight, cost and take full benefit of the volume and also do their inspection. Impact crushers contain the use of impact rather than pressure to crush materials. Here the material is held within a barred enclosure, with openings of the number one size at the bottom, end or at sides to agree crushed material to discharge through them. This category of crusher is generally used with soft materials like coal, seeds or soft metallic ores. The mechanism used here is of Impact loading where the time of use 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 well thought-out to be subjected to torsion and bending.

Ramakrishna S. More, Sunil J. Rajpal (2013) [5] had represented Crushers are major size reduction equipment used in mechanical , metallurgical and allied industries which crushes different types of soft and hard materials. Swing jaw plates are takes direct part into this operation. Hence the design and analysis are very important .This paper focuses on review of a work carried out by researchers on analysis of swing jaw plate i.e. Kinematic & dynamic analysis of the jaw crusher. Due to which the design quality of jaw crusher are improved, though there were so many researcher work done on analysis, but still there is so many area of scope to develop the analysis of swing jaw plate.

Eugeniusz Rusiński, Przemysław Moczko, Damian Pietrusiak, Grzegorz Przybyłek (2013) [6] investigates into the causes of fatigue cracks of a jaw crusher supporting structure are presented. The problems appeared after short time of operation at a new crushing facility. A large number of fatigue cracks with a high growth rate and bolt failures were observed in the crusher supporting structure. Considering the high dynamic forces that occur during the operation of such equipment, an investigation into the problem was undertaken in order to prevent catastrophic failure of the crushing station. A specially developed, combined numerical and experimental method was used to determine the reasons for the problems and to solve them.

Ashish Kumar Shrivastava, Avadesh K. Sharma(2012) [7] had represented 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 behaviour 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, this paper 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.

Shivam Choudaha, Sunil Kumar Tiwari, Sarang Pande (2012) [8] had represented machines used to break or compress using the metallic plates during mining of materials. The chronic problem of High Maintenance cost and extensive downtime in Jaw crusher. In this paper this problem is solved by implementing various techniques like process mapping, why why analysis, Brain storming and appropriate use of plan-do-check-act (PDCA) cycle. The developments achieved by these techniques led to increase in customer satisfaction and productivity enhancement. The Customer requirement of Crushed Bath has been fulfilled by increasing the availability by 17%, Eliminating Breakdown, Reducing the MTTR by 89% and Maintenance Cost by 86% of Jaw Crusher. The study is helpful for gaining improvement in similar field as well as also in others.

A. Refahi, J. Aghazadeh Mohandesi, and B. Rezai (2009) [9] had represents Predicting the energy consumption during the size-reduction process, the Bond approach is often used. The PFC3D discrete element method (DEM) software was employed to model the crushing behaviour of some rocks with different mechanical properties in a laboratory jaw crusher. FLAC3D software was adopted to analyze the stress distribution in the rocks. The rocks studied were modeled as granular assemblies in the

shape of a sphere and/or a cube located between two jaws and the work done by the jaws in the crusher was determined. Nine different types of rocks were studied and the energies consumed by the crusher were compared to those of the Bond comminution energy estimated from the Bond index. There is considerable difference between Bond crushing energy and work done by the jaw crusher for rocks. It appears that the Bond approach is not a suitable method for predicting single particle fracture energy done by the crusher. To verify the results obtained from DEM models, the fracture behaviour of the crushed rocks was examined and was compared to the PFC3D results. The tensile mode of fracturing is favourably modeled by the PFC3D software while the delamination mode cannot be well modeled by PFC3D software.

Emrod Elisante (2009) [10] had represents A small-scale mobile jaw-crusher unit with a throughput of 1-1.5 tons of aggregates per hour has been designed, manufactured and tested at the Department of Chemical and Processing Engineering, University of Dares Salaam. The equipment is aimed at reducing the drudgery and hardships faced by artisanal miners, mostly women, who spend long hours in quarrying sites excavating and crushing aggregates using manual tools. The aim was to design a low-cost unit powered by bicycle pedals however this objective was defeated by economic constraints like labor cost and product price, as well as, technical limitation of the human physique and stamina to sustain pedaling of heavy inertial flywheels required to overcome the actual load and intermittent shock-loads. Instead a simple air-cooled engine 2.94 kW was used causing a 25% increase in investment cost but had 6 fold improvement in productivity over bicycle power and 30 fold boost over manual tools like sledge hammer, pickaxe and crowbars previously used by miners. The crusher was successfully field tested for 3 months by Umojani Nguvu women group at Kunduchi Mtongani quarry site to crush 6-8" limestone rocks to aggregates of various sizes ½", ¾" and 1" required for road and building construction of roads on the outskirts of Dares Salaam city. Based on the field data and an investment cost of T_{she} 3.5 million, a financial profitability analysis indicated that the crusher project has a daily net-inflow of T_{shs} 259 thousand and a pay-back period of two months. Since the unit requires low level of technical skills and is not capital intensive it is recommended for micro- and medium scale aggregates miners and can be deployed in peri-urbanquarries or remote villages without electricity grid.

V. ACKNOWLEDGMENT

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VI. CONCLUSION

The research survey was reflected different types of crusher machines such as bottle crusher machine, can or plastic bottle crusher machine, Cone crusher, Jaw crusher, Impact crusher, small-scale mobile jaw-crusher etc. The research had survey on their design and analysis of each component.

Some research paper indicated about Finite Element Analysis of some critical components in CAD software such as Pro/Engineer, FLAC3D from this research reflected to checked behavior of different component in static condition.

There was not work done on core component of jaw crusher such as swing plate static and dynamic analysis. Also optimization with respect to weight and shape of swing jaw plate.

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