EXPERIMENTAL EFFECT ON JAW CRUSHER PLATE

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ABSTRACT

This paper shows the tested in jaw crusher weight loss in plate due to impact, abrasive material and combination of both using stone. The wear rate is determined by weight reducing in the specimen of jaw plate. Total plate is running near about 5 months which wear more 40%. After testing it is found that wear in stationary jaw plate and moving jaw plate is different in wear. The stationary plate is more wear than moving plate. The different wear rate for stationary jaw plate and moving jaw plate is based on work hardening effect during running-in period and to the different wear micromechanism acting on the jaw surfaces.

Keyword: - *Jaw crusher, Impact, Abrasive wear, micomechanism*

1. INTRODUCTION

Wear in stone crusher plate is depends upon the three factors, 1) Impact Force on the plate, 2) shearing in plate (Abrasive Wear) and 3) Combination of Impact Force and Abrasive Wear.

For handling this condition surface hardness required is more. Thus, two factors play an essential role on hardness increase: the hardness of mechanical contact and microstructure. Many variations of the original austenitic manganese steel (AMS) are available, often in unexploited patents, but only a few have been accepted as important achievement. These usually involve variations of carbon and manganese, with or without additional alloys such as chromium, nickel, molybdenum, vanadium, titanium, and bismuth. The mechanical properties of AMS vary with carbon and manganese content. As carbon is increased it becomes increasingly difficult to retain all of the carbon in solid solution, which may account for reduction in tensile strength and ductility. Nevertheless, as the carbon increases above 1.2 %, the abrasion resistance increases, while, the ductility is lowered. The carbon content is usually below 1.4 % and 13 % manganese due to the difficulty of obtaining an austenitic structure sufficiently free of grain boundary carbides, which are detrimental to strength and ductility.

2. MATERIALS AND METHODSJ

Jaw crusher jaw plate overview:- Jaw plate is manufactured with super high manganese steel, therefore it has a service life 50~100% longer than those made of traditional high manganese steel. Every model of PE series jaw crushers is tested for shock, stress, strain, thermal loading, deformation, vibration and noise under a wide range of load conditions.

Table 1and Table 2 presents the final chemical composition of sand-cast jaw crusher plate.

Table No.1- Chemical Component of jaw plate-

Material	**Chemical composition(%)**				**Mechanical property**
	C	**Si**	**Mn**	**Cr**	**HB**
Mn13Cr2	1.1-1.4	1.7-2.2	12-15	1.7-2.2	≤220
Mn18Cr2	1.1-1.4	1.7-2.2	17-19	1.8-2.2	≤230

Table No.2 - Chemical composition (mass %) of steels used on jaw crusher test.

Type	C	Si	Mn	Ni	P	S	Cr	Al	Fe
New spec jaw plate (NSJP)	1.23	0.60	12.80	-	0.005	0.006	2.4	-	Bal
Typical local jaw Plate	1.27	0.90	12.6	0.40	0.60	0.05	2.1	0.08	Bal
Foreign manganese jaw plate	1.02	0.50	13.00	0.202	0.002	0.001	1.4	0.006	Bal

Table No. 3-Manufacturing detail of jaw plate:

Jaw Plate	
Name	Jaw plate, swing jaw plate, fixed jaw plate, toggle late, movable jaw and fixed jaw, jaw crusher
Material	Mn13Cr2(M1 equivalent grades), Mn18Cr2(M2 equivalent grades)
Control	Spectrometer chemical analysis and control while producing
Molding process	Water-glass sand casting or lost form casting
Melting facility	Medium frequency electric furnace
Heat Treatment	Anneal, quenching, tempering
Quality Guarantee	One year against manufacturing defeat
Testing	Hardness, flaw detector test
Certificate	ISO9001~2008 Passed; BUREAU VERITAS
Application	Cement firms, coal fired power plant ,mining firms ,metallurgy ,quarry firms

3. Wear Test

3.1 Wear Characteristics

The performances of the weight measuring effect we calculate how much it is wear. For the calculation we measure initial weight of the plate and again measure the weight after crushing the stone. The Utility of the plate in percent was evaluated as

$$\text{Utility} = \frac{\text{Initial weight} - \text{Final weight}}{\text{Initial weight}} \times 100\%$$

3.2 The impact load distribution along the swing plate:-

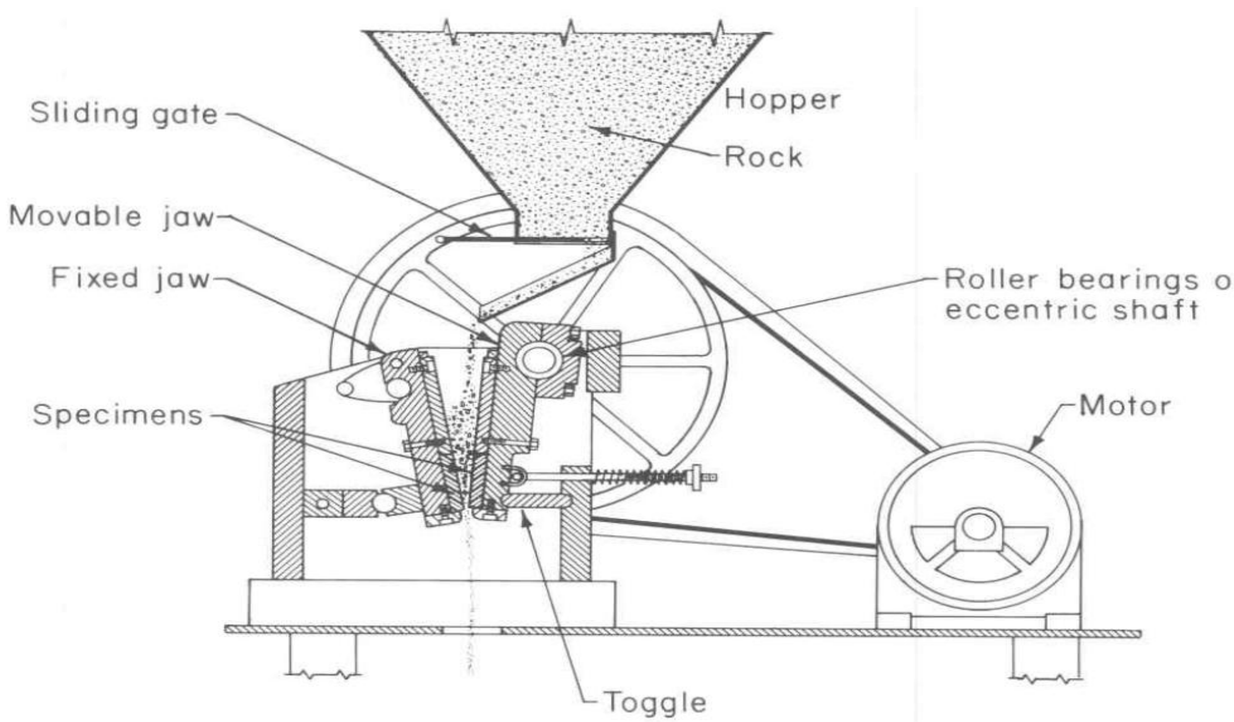


Fig.1- Elevation View of Jaw Crusher

The parameter which most controls the design of the Jaw Plate is the load distribution, shown in Fig.1.This hypothetical distribution, was only concerned with the total loading force. Instrumentation of toggle arms in Germany has since led to correlation of measured impact force with rock type. The most complete consideration of the effect of rock properties on impact force and the toggle force. His work is based upon the three-point loading strength of the rock, which he found to be one-sixth to one eleventh the unconfined compressive strength. The hypothetical toggle forces based upon the sum of forces necessary to crush a distribution of regular prisms fractured from an initial cubical rock particle. These approaches involved both maximum resistance and simultaneous failure of all particles and thus neither can lead to an interactive design method for changing stiffness (and weight) of the Jaw plate.

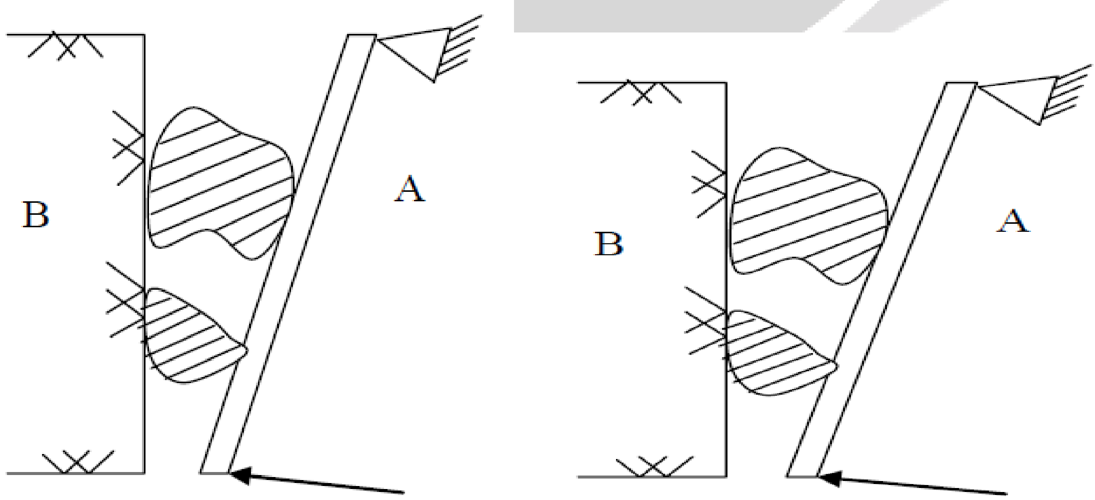


Fig.2. Point Load Failure (PDF) Mechanism

Normally, the stiffness and dimensions of Jaw Plates are not changed with rock type and all plates are capable of crushing rock such as taconite with an unconfined compressive strength of up to 308 MPa. Only the facing of the Jaw Plates changed with rock type, to account for changes in abrasiveness or particle shape. For instance, ridged plates are employed with prismatic particles both to stabilize the particles and to ensure the point loading conditions. Communications with manufacturers of jaw crushers have revealed that no consideration is currently given to force displacement characteristics of the crushed rocks in the design of Jaw plates.

Consideration of the two particles between the crusher plates in Fig.3.2 reveals the importance of the point-load failure mechanism. As a rock tumbles into position it will catch on a comer of a larger diameter and thus will be loaded at two ‘points’ of contact. Throughout the paper, ‘point’ describes contact over a small and limited region of the circumference of the particle. Should flat-sided contact occur, the ribbed face plates of most crushers will apply point loads to the particle. The particle will then fail either by two or three point loading. Thus, any design based upon both deformation and strength must begin with a point-load idealization.
The PDF value and wear value is change due to change the type of rock.

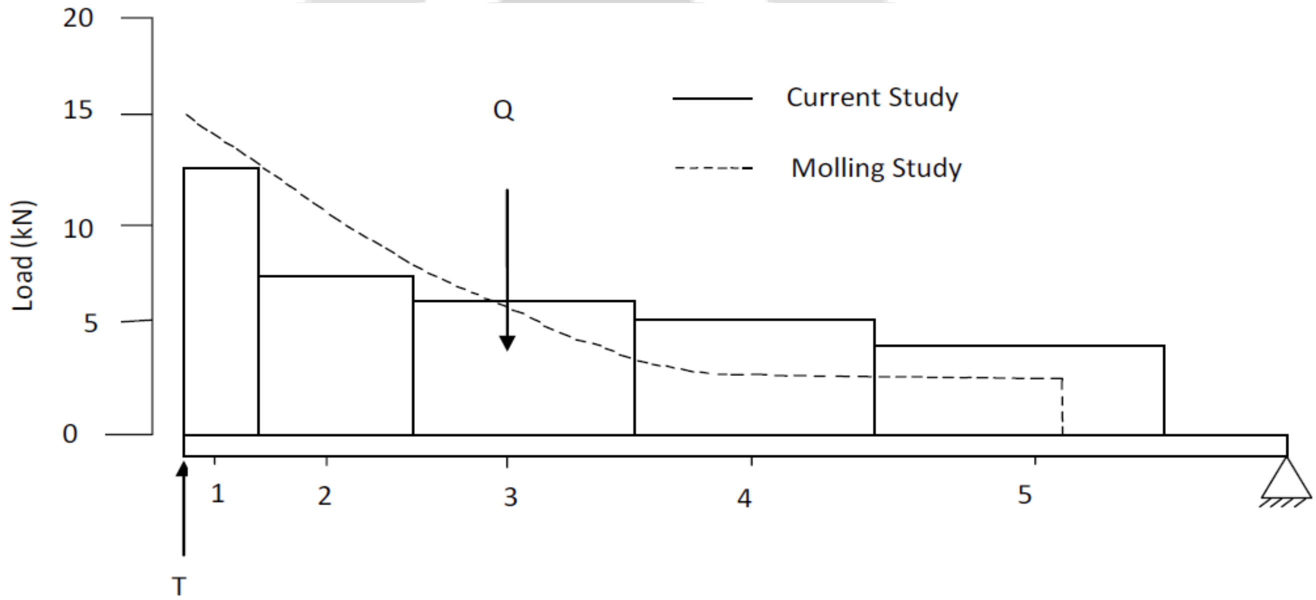


Fig.3. Load Distribution along Plate A Only.

Table No. 4 –Different types stones Crushing Strength Value

Rock Type	Crushing Strength MPA	Aggregate Crushing Value	Abrasive Value	Impact Value
Basalt	207	12	17.6	16
Granite	193	20	18.7	19
Limestone	171	24	16.5	9
Porphyry	239	12	19	20
Gritstone	229	12	18.1	15

3.3 Abrasive wear:-

Abrasive wear tests are frequently classification by the type of test equipment used, they can be classified in more general terms by the stress level and the geometrical arrangement of the components of the system. If the load is sufficient to fracture the abrasive particles, the wear is called high stress abrasive wear, if the particles do not fracture significantly; it is called low stress abrasive wear. The distinction between low stress and high stress conditions is not sharp. As for geometrical arrangement, if the abrasive particle is in contact with only one other object, it is called two body abrasive wear. If the particle is engaged by more than one other object, such as another wear surface or other abrasive particles, it is called three body wear. Although the abrasive material is normally harder than the wear object, this is not a necessary condition for classifying the wear as abrasive wear.

3.3.1 Jaw Crusher Gouging Abrasion Test:-

Gouging wear occurs in many mining operation, for example, where excavator teeth or loaders penetrate or drag over rock, and in jaw and gyratory crushers. Gouging wear is identified by the removal of a significant amount of material from the wear object after an encounter by the abrasive object in which the abrasive object also suffers damage. It is a type of high stress wear that may be produced by either two-body or three-body abrasive wear. The jaw that crush the rock are taken as the test specimen. Several investigators believe that the jaw crusher test gives the closest correlation to wear that occurs on earth penetrating equipment, such as excavator teeth, power shovel buckets, scoops, and grader blades, as well as real jaw crusher wear..

A small commercial laboratory jaw crusher was modified to accept an easily machined, identical pair of test wear plates. One test plate and one reference plate are attached to the stationary jaw and the other test and reference plate are attached to the movable jaw, such that a test plate and a reference plate oppose one another. A rock hopper and rock chute are attached above the jaw crusher. The Arrangement of jaw crusher test equipment is shown in fig.1 and a photograph is presented in fig.4. the jaw crusher operates at 340c/min.

Fig.4- Jaw Crusher gouging wear test machine.

The test wear plates and reference wear plate have a 20º to 23 º taper on each end for clamping to the jaw. All specimen surface are machined on a surface grinder. The small size of the specimens has a distinct advantage because previously used specimen from stone abrasion tests can be used in the jaw crusher after regrinding. The standard reference material used is a low alloy steel, ASTM A514, with brinell hardness of HB <230.

After the impacting stones from the hopper in jaw plate, the minimum opening is 45 mm and 40kg load of rock crush 12mm, 16mm, 20 mm is run through the crusher. The weight loss may be calculated from the mass loss, determined by weighting, and the known densities of the test materials. A wear ratio is developed by dividing the weight loss of the test plate by the weight loss of the reference plate. This is done separately for the stationary and movable plates. The two wear rations are then averaged for a final test ratio.

3.4. Combine Effect of wear:-

The value of jaw crusher calculated randomly reading of complete after working. The observation found in practical reading as follow.

Table No.5 Randomly working reading of complete day

Model	OSS (mm)	CSS (mm)	Capacity (T/Day)	RPM	Drive (H.P)	Wear(gm)		
						Fixed	Moving	Total
20”X10”	250	45	162	325	40	258	122	370
20”X10”	250	45	170	325	40	260	130	390
20”X10”	250	45	165	325	40	245	115	355
20”X10”	250	45	170	325	40	260	112	372
20”X10”	250	45	156	325	40	245	110	355
20”X10”	250	45	182	325	40	265	120	385
20”X10”	250	45	138	325	40	205	95	300
20”X10”	250	45	152	325	40	235	111	346
20”X10”	250	45	164	325	40	235	115	350

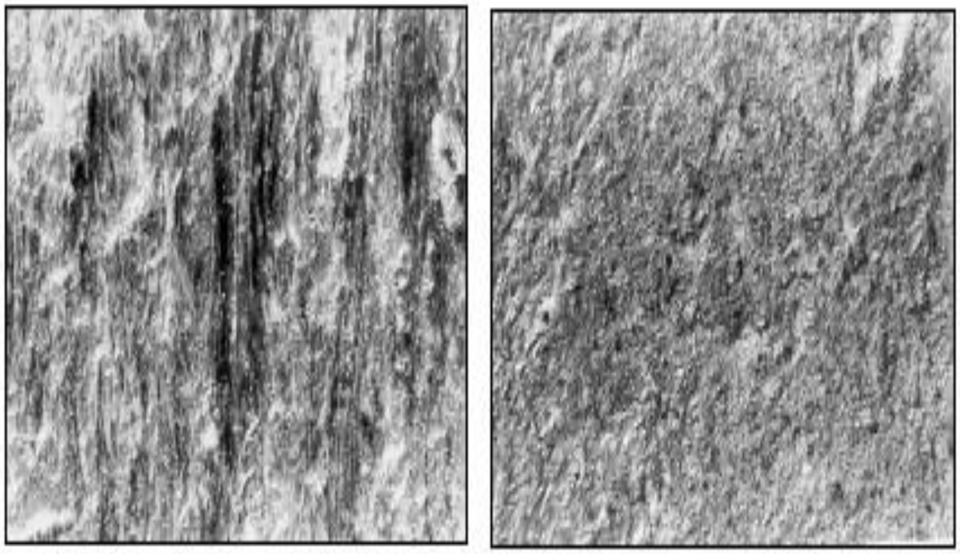
Four specimens was tested with their full life period. Every new plate weight is 150 kg, In which weight is measured before inserting plate and run near about 2.5 months and again interchange their place with measuring the weight. The observation reading table is as follow.

Table No. 6 complete life period of jaw crusher plate

Sample	First Session		Second Session		Total wear in Kg	Average in Kg
	Movable Plate in Kg	Stationary Plate in Kg	Movable Plate in Kg	Stationary Plate in Kg		
A	136.2	-	-	83.4	66.6	66.125
B	-	105	87.8	-	72.2	
C	138.8	-	-	93	67	
D	-	109	91.3	-	58.7	

4. Microstructure

Samples obtained from the jaw crusher plate prepared for metallographic examination using nital as etchant after preliminary grinding and polishing operations. An optical metallurgical microscope was used to obtain 250X photomicrographs of the processed samples. The micrographs are shown in Figures 5.



(A) (B)

Fig.5- Aspect of worn surface 25 X.
(A) Stationary Jaw Plate.
(B) Moving Jaw Plate.

Conclusion:-

1. The surface micro hardness of cast steel moving and stationary jaws after crushing test was 40% greater than initial value.
2. The surface micro hardness of movable and stationary jaws was constant, independent to the crushed granite amount.
3. It is found that stationary jaw plate is more wear than movable jaw plate. Stationary plate is near about three times more than movable jaw plate.
4. Consideration of the two particles between the crusher plates reveals the importance of the point-load failure mechanism. Thus, any design based upon both deformation and strength must begin with a point-load idealization.

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