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"DESIGN & PARAMETRIC STUDY OF SWING JAW PLATE WITH ANSYS SOFTWARE"

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ABSTRACT

Crushers are the major size reduction machine used in the mineral, mining, and mechanical industries. It crushes hard and soft material to reduce its size. Nowadays, 1:7 reduction ratio machines are available. Swing jaw plates are the main wearing part of the crushers which directly take part in crushing the stones. So, it leads the design and analysis to be very important. Present work is based on the work done by the researchers in analysing the swing jaw plates, on which the static load analysis has been done. In future there is still so many areas of scope have to be developed to analyze swing jaw plates. With the help of CATIA software, a model of jaw plate is made and, by importing this model to ANSYS software static load analysis is done. The change found during the analysis of swing jaw plate are calculated. The modified stiffened-plate model is estimated to stress\weight ratio and change in stress/weight ratio (in %)

Keyword: *Jaw Crusher, Catia, Ansys, Stiffened-Jaw Plate, FEA, Swing jaw.Plate.*

I. INTRODUCTION

Jaw crushers are the size reduction machines by the compression between the jaws. It were first manufactured in 1960.Double toggle type of crushers were first made. But today single toggle crushers is most popular today and is found in many crushing operations.jaw crushers are used for crushing the different variety of materials in mining, minerals, and steel industries. They are further used in recycling processes also. Jaw crushers are used for the size reduction of the materials, which is been, crushed in between the jaws plates in the crushers. Therefore, swing jaw plates are the weary part of the jaw crushers.Jaw crushers are probably the most easily recognized crushers in any quarry operation. They are also probably the oldest style of mechanical crusher, neglecting spelling hammers and stamp batteries.

Jaw crushers generally consist of a heavy-duty steel "box", fitted with a fixed vertical crushing "jaw" at one end and a moving "jaw" opposing it, with a method of transferring motion to the moving jaw. The moving jaw swings towards and away from the fixed jaw, creating a squeezing action (compression) on the rock. The opening between the fixed

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and moving jaws tapers vertically from wide at the top to narrow at the bottom, thus gradually reducing the size of the rock as it moves down through the "crushing chamber". The jaw plates can be flat, ribbed, corrugated or a combination of these, although corrugated jaw plates are now most commonly used in quarrying operations.

In Today's quarrying operations there are two styles of jaw crushers that are generally employed; single toggle and double toggle (or Blake) crushers. Over the years there have been other designs of jaw crushers, notably the horizontal pitman style and the Dodge machine. It is rare to find either of these machines today, as the crushers were limited in their ability to crusher hard materials at economical rates due to fairly inefficient transfer of crushing forces to the jaw plates.

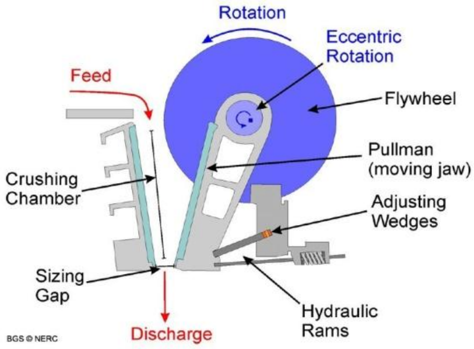

Fig1.2Double Toggle (Blake) Jaw Crusher

In the double toggle machine the moving jaw (swing jaw) is pivoted at the top on the concentric swing-jaw shaft fitted with plain bushes, either in the frame of the crusher or in the swing jaw.

II. METHODOLOGY

2.1 Design of Jaw Plates

Total energy consumption in the crushers is of major importance in the industries. There are many attempts are made to increase the strength / ratio, are common with the researchers. When the weight of the swing plate will decrease, it will consequently decrease the stiffness also. So to analyze for the energy saving in the jaw crushers while crushing the materials, relationship with the stress and deflection are studied with point load deformation. For such a investigation to be carried out, a model has been created using CATIA and FEA is done, by using ANSYS software. Firstly, various Swing jaw plates ranging from plate size thickness 140 mm to 224 mm were analyze and then by attaching stiffener numbers one by one up to four stiffeners. Effects of the stiffeners were analyzed.

Elastic Modulus (E) = 210 GPa

Mass Density (ρ) = 7440 kg/m^3

Poisons ratio (ν) = 0.3

Shear Modulus (Φ) = 80.76 GPa

Yield Strength (Ys) = 350 MPa

Tensile ultimate strength = 940 MPa

For our work, we have chosen the crusher dimensions with, Top opening 304 mm and bottom opening 51mm.

2.2 Solid Modeling of Swing Jaw Plates

Various 3d model of Swing jaw plate has been made with different plate thickness.CATIA is a CAD software used to make different object, drawings and draft them in 2D or 3D. Here we have use the Catia for creating a model of swing jaw plate, which will further be imported to ANSYS software. Modeling can also be done on ANSYS, it is difficult to make and modify complex geometries in it, and requires knowledge in CAD.

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But, in CATIA, with basic knowledge, our model has been created.

1) Go to file > New > Part > Ok
2) Selection of Axis plane, xy- plane is selected
3) Then >Sketcher, Draw the Sketch
4) Save the Sketch by Save button
5) Exit, Sketching Workbench.

Extruding the sketch

1) Invoke the Pad tool by clicking on it
2) Pad Button > Pad Definition
3) Ste length in the pad Definition dialog box to 1200mm % then OK
4) After OK, the Geometry is createdNow, view the model in Isometric, by using the isometric view button. After extrude, our model is created, which is shown in the fig no.7
5) Save file & CloseAlso, save file in IGES format, to further import in ANSYS software

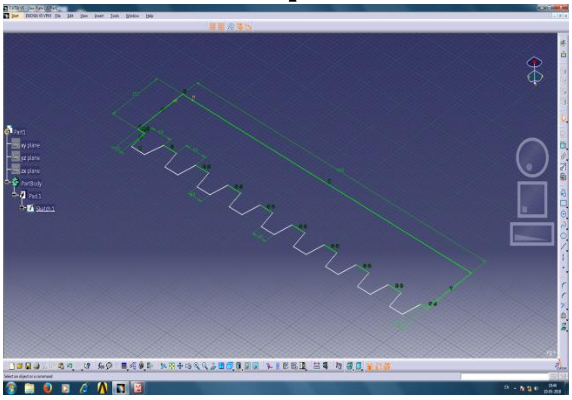

Fig. 2.1 Sketch of swing jaw plates base feature

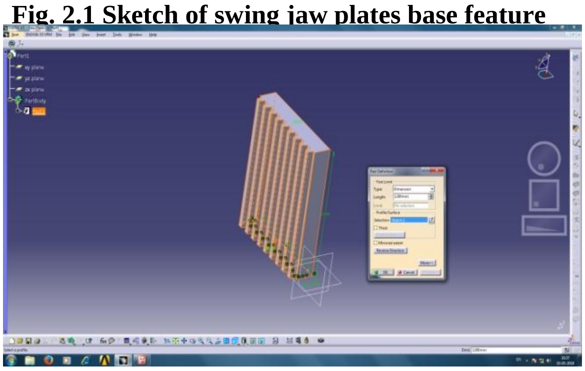

Fig. 2.1 Sketch of swing jaw plates base feature

2.3 Assumptions

For the study of jaw plate in response to the load acting on it ,we are required to give assumptions also. Our analysis is based on the assumption the point loads are acting over the jaw plate surface. Loads of various different sizes of particles are acting perpendicular to the17 plate. Steady load and steady response. That is, the loads and the jaw plate response are assumed to be very slow with respect to time.

2.4 Defining of Material Properties

Elastic Modulus (E) = 210 GPa, Mass Density (ρ) = 7440 kg/m, Poisons ratio (ν) = 0.3, Shear Modulus (Φ) =80.76 GPa, Yield Strength (Ys) =350MPa, Tensile ultimate strength = 940 MPa

Work Hardening Steel with Manganese=11-14% and Carbon=1%)

Austenitic Manganese steel is produced to the hadfield specification .So, it gives optimum wear and work hardening properties and also it is non-magnetic. This steel has major application in crusher's plates.

Materials	Mn (%)	C (%)	Si (%)	S (%)	P (%)
ASTM 128 Gr B2	1.05 – 1.2	11.5 – 14	Less than 1.0	----	Less than 0.070
Titus Manganese	1.13 – 1.2	11.5 – 14	Less than 0.40	Less than 0.003	Less than 0.020

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Table 2.1.2 Mechanical Properties

YIELD	Ultimate tensile strength at 20° C (68° F)	Percentage Elongation	CHARPY Kcvl 20°C (4°F)	Brinells hardness
350 MPa	940 MPa	(5d)	>140J/sq.cm	220 to 540

Titus 11-14% Hadfield Manganese Vs Low Carbon Manganese

30-50% MORE SERVICE LIFE WITH INCREASED HARDNESS

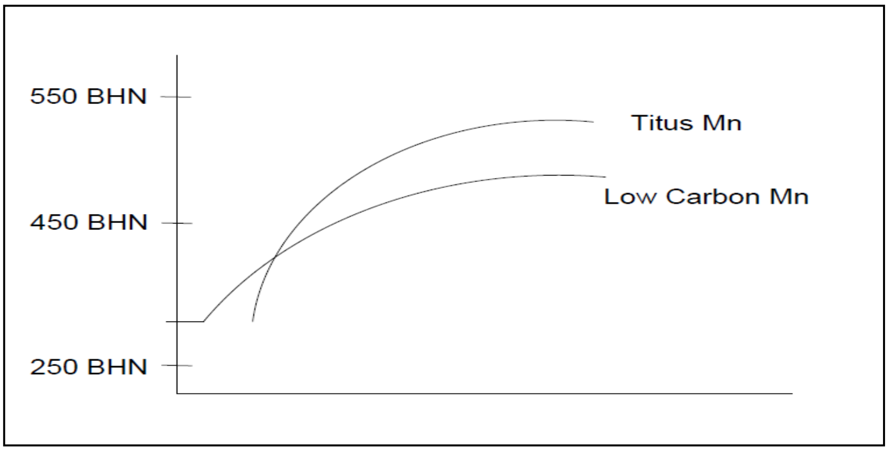
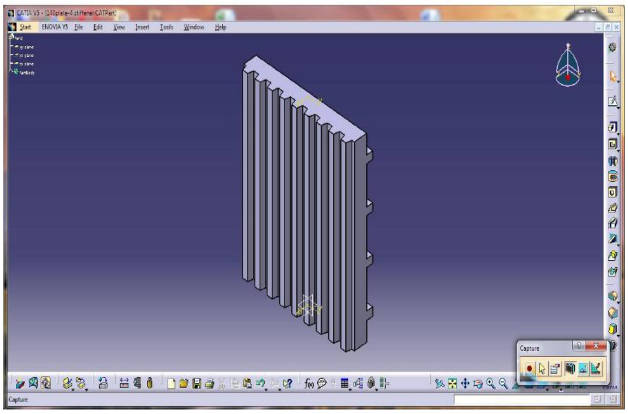


Fig.2.4 Graph of hardness of Hadfield Manganese Vs Low Carbon Manganese

- Brinell points of hardness have increase to more 100 value.
- More hardness in the material due to 35% carbon.
- Decrease in fatigue cracks due to ample decrease in sulphur contents.

III. DEFORMATION ON SWING JAWS PLATES

3.1 Swing Jaw Plates Static Stress Analysis with Stiffeners:



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IV. SIMULATIONS ANALYSIS

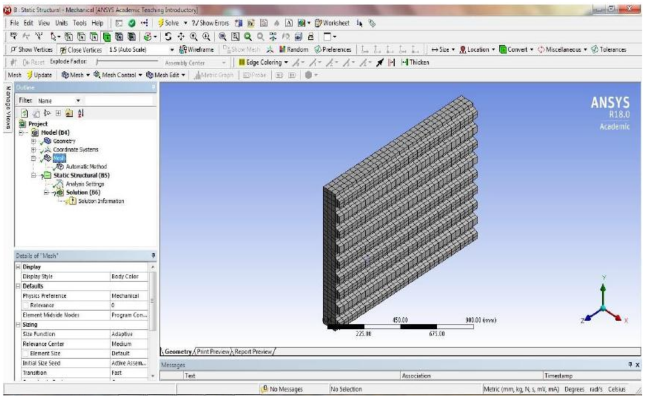

Fig.4.1 Meshing

4.1 VON-MISES STRESS IN SWING JAWS PLATES

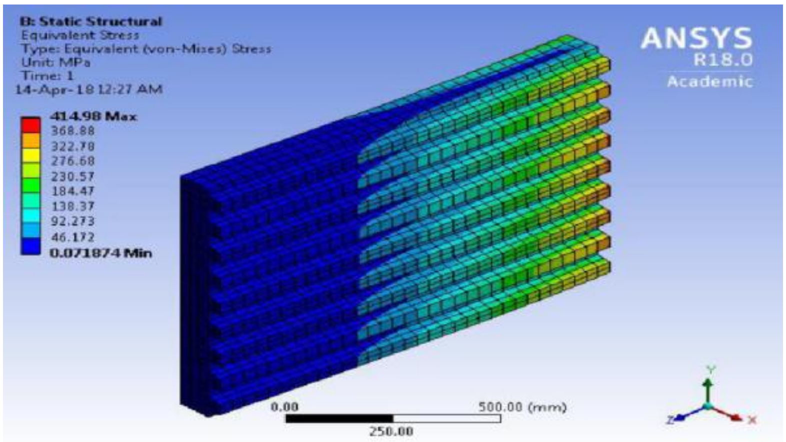

Fig.4.2 Equivalent stress of Swing Jaw plate

Table 4.1 - Stresses in jaw plate

Sr. No.	Thickness of Jaw Plate	Stress (in MPa)				
		N=0	N=1	N=2	N=3	N=4
1	140	414.98	374.15	**375.86**	372.62	368.24
2	152	351.45	314.53	314.6	**315.11**	314.52
3	165	299.05	268.52	247.44	**269.37**	268.52
4	178	257.74	232.69	232.26	**233.4**	232.83
5	191	224.94	180.47	203.71	203.74	**204.05**
6	203	200.06	151.72	149.93	181.93	**182.54**
7	216	165.92	151.57	151.4	**152.13**	151.38

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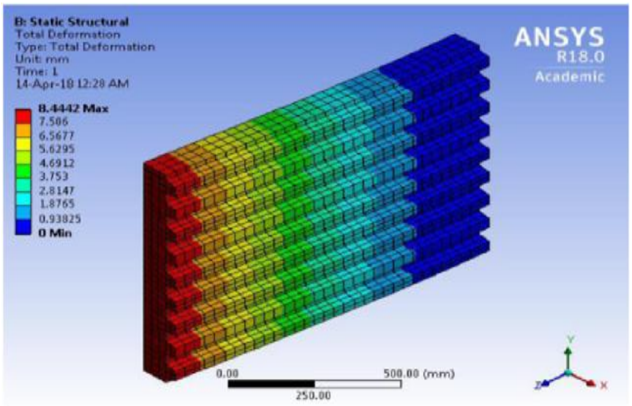
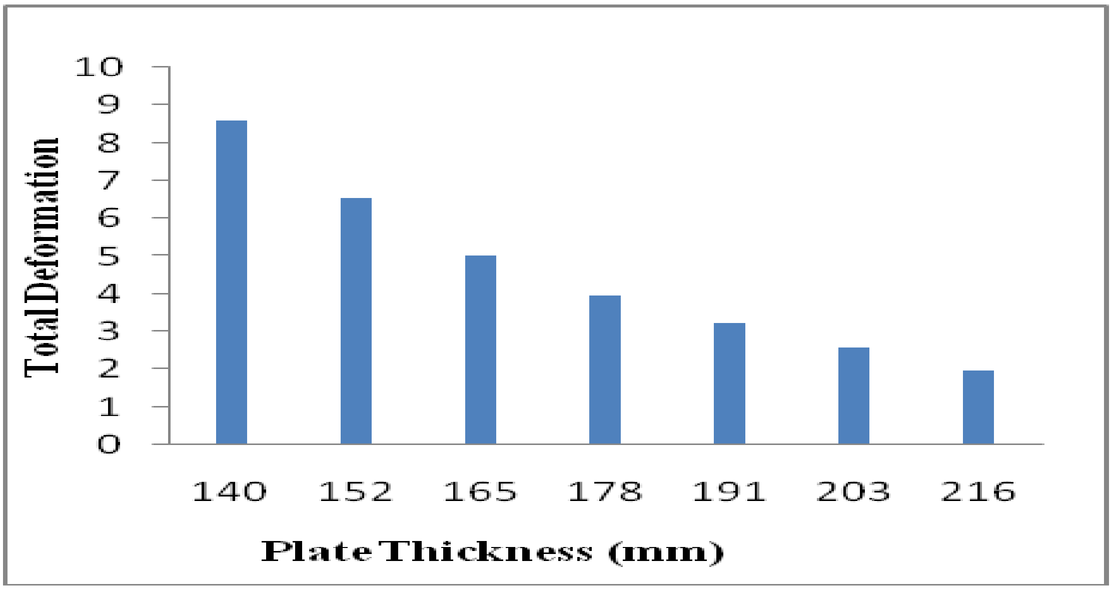


Fig.4.36 Total Deformation in Swing Jaw Plate

4.4 GRAPH OF DEFORMATION IN SWING JAW PLATES



V. RESULT

5.1 STATIC STRESS ANALYSIS RESULTS

The results of the static stress analysis of the swing jaw plates with stiffener and without stiffener are shown in the below table. Which indicates that, thereis much new improvements in the design of the swig jaw plates with stiffeners. With the more hardened and less sulpur content material, the stress bearing capacity of the swing jaw plates has increased with the addition of stiffeners, and this material ,manganese steel will surely give longer service life of the jaw plates.

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Table 5.1 Max.tensile stress and maximum deflection on various thickness plates

Jaw Plate Thickness mm	Stiffness (KN²) X10⁵	Max. Tensile Stress (MPa) ANSYS Analysis	Max. Deflection (mm) ANSYS Analysis	Max. Driving Force (T) (MN)
216	1.74	165.92	1.90	1.17
203	1.33	200.06	2.59	1.17
191	1.10	224.94	3.14	1.17
178	0.90	257.74	3.93	1.17
165	0.73	299.05	5.00	1.17
152	0.55	351.45	6.49	1.17
140	0.44	414.98	8.44	1.17

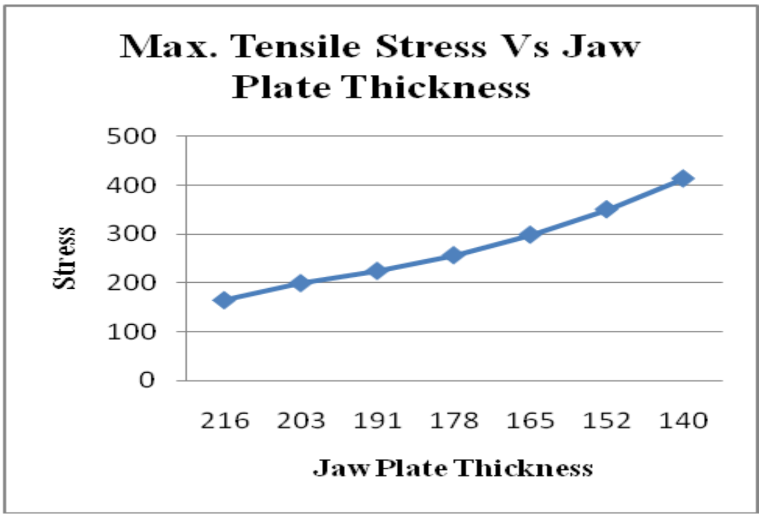

Fig.5.1 Max. Tensile Stress for Various Jaw Plate Thicknesses

5.2 EFFECT OF STIFFENERS ON SWING JAW PLATES

Jaw Plate Thickness	Stiffness (EI) (KN/m^2) X 10^5	Number of Stiffeners				Max. Driving Force (MN)
(mm)		N=1	N=2	N=3	N=4	
216	1.74	151.57	151.40	**152.13**	151.38	1.17
203	1.33	151.72	149.93	181.93	**182.54**	1.17
191	1.10	180.47	203.71	203.74	**204.05**	1.17
178	0.90	232.69	232.26	**233.40**	232.83	1.17
165	0.73	268.75	247.44	**269.37**	268.52	1.17
152	0.55	314.53	314.60	**315.11**	314.52	1.17
140	0.44	374.15	**375.86**	372.62	368.24	1.17

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5.3 CHANGE IN STRESS/WEIGHT RATIO (IN %) USING STIFFENERS

From the table date the Savings in energy were calculated, we came to find that, there is saving of energy, that means lower power motor can be used to drive the eccentric

5.4MASSOF VARIOUS THICKNESS JAW PLATE:

Change in stress/weight ratio (in %)					
Thickness	N=0	N=1	N=2	N=3	N=4
140	0	11.16%	12.04%	14.05%	**16.25%**
152	0	11.63%	12.79%	13.80%	**15.08%**
165	0	11.33%	**19.30%**	13.21%	14.53%
178	0	10.65%	11.84%	12.41%	**13.60%**
191	0	**20.53%**	11.25%	12.18%	12.97%
203	0	24.85%	**26.49%**	11.68%	12.26%
216	0	9.41%	10.37%	10.79%	**12.05%**

shaft, which in turn gives the crushing movement to the movable jaw. moreover ,the strength to weight ratio has increased with stiffeners, which most importantly reduces the inertia of the jaw crusher.
Thus the cost of the machine is also reduced, with decrease in maintenance

Table 5.3 Comparative data of Various Jaw Plates with and without stiffeners

Stress/Weight Ratio					
Thickness	N=0	N=1	N=2	N=3	N=4
140	0.0376	0.03341	0.03307	0.03232	**0.03149**
152	0.02933	0.02592	0.02558	0.02528	**0.02491**
165	0.02299	0.02039	**0.01856**	0.01996	0.01965
178	0.01837	0.01641	0.01619	0.01609	**0.01587**
191	0.01494	**0.01187**	0.01326	0.01312	0.013
203	0.0125	0.0094	**0.00919**	0.01104	0.01097
216	0.00974	0.00883	0.00873	0.00869	**0.00857**

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Table: Mass of various thickness plate

Mass of Jaw Plates

S. No.	Thickness	Mass in Kg				
		N=0	N=1	N=2	N=3	N=4
1	140	1124.92	1141.66	1158.4	1175.14	1191.88
2	152	1221.35	1236.9	1253.64	1270.38	1287.12
3	165	1325.81	1342.54	1359.28	1376.02	1392.76
4	178	1430.26	1445.22	1461.96	1478.7	1495.4
5	191	1534.72	1549.38	1566.12	1582.86	1599.6
6	203	1631.14	1646.1	1662.84	1679.58	1696.32
7	216	1735.61	1750.26	1767	1783.74	1800.48

VI. CONCLUSION

There is a reduction in the weight of the plates, which indicate for the design of a light weight machinery as a whole ,with less inertia. In our result ,it is found that the, stress bearing capacity of the various plates obtained from the analysis are enough to crush the material up to 414 MPa. Increase in the number of stiffener also increase the strength / weight ratio of the plates. So, due to this reductions in the weight, there is indication of new design with more save in the energy. as the jaw plates material is saved ,the material cost also get reduced. with stiffener, strength of jaw plate is more ,than that of jaw plates without stiffener.

VII. FUTURE SCOPE

1. The effect of stress and displacement can be studied
2. Dynamic analysis can be carried out to determine the vibration levels
3. Varying packing arrangements from the simplified row assumption to random distributions found in actual operation can be applied to get more accurate results.

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