Exploring the Possibility of using E-glass /Epoxy in the design of single toggle jaw crusher

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Abstract— *Jaw crusher is a kind of size reduction machine that is wide utilized in mineral, aggregates and metallurgy fields. The interaction between jaw plates and material particles brings the inevitable and high wear to the jaw plates throughout the jaw crusher operation, that not only decreases the efficiency, however also will increase the price and also the energy consumption of the jaw crusher. Obtained results from the kinematic analysis of the moving jaw and also the crushing force distribution analysis, the jaw plates wear is analyzed on a macroscopical level. It's useful to design the crusher for improved performance. Efforts to decrease energy consumed in crushing have cause thought of decreasing the weight of the swing plate of jaw crushers. Design of lighter weight jaw crusher would require a lot of precise accounting of the stress and deflections within the crushing plates than is available with ancient technique. The objective of this project is to present modeling and analysis of single toggle jaw crusher and comparison of deformation and stress, load and weight savings results between manganese steel single toggle jaw crusher and composite single toggle jaw crusher under same conditions. This study gives information about the replacement of manganese steel jaw crusher with composite jaw crusher made of E glass/epoxy. The single toggle jaw crusher is to be solid modeled in proE and analysis is to be carried out by using ANSYS workbench13 for effective comparison.*

Keywords— single toggle jaw crusher, manganese steel, E glass/Epoxy, stiffeners, Auto CAD, ANSYS 13.0

I. INTRODUCTION

Crushing is that the process of reducing the dimensions of the lump of ore or over size rock into definite smaller sizes. Based on the mechanism used devices are of three types particularly Cone crusher, Jaw crusher and Impact crusher. The first stage of size reduction of hard and huge lumps of run of mine (ROM) ore is to crush and reduce their size. The mechanism of crushing is either by applying impact force, pressure or a combination of each.

Jaw crushers are usually used as primary crushers, or the primary step within the method of reducing rock. They typically crush using compression. The rock is dropped between two rigid pieces of metal, one in all that then move inwards towards the rock, and therefore the rock is crushed as a result of it's a lower breaking point than the opposing metal piece. Jaw device movement is obtained by employing a pivot point located at one end of the "swing jaw", and an eccentric motion located at the opposite finish.

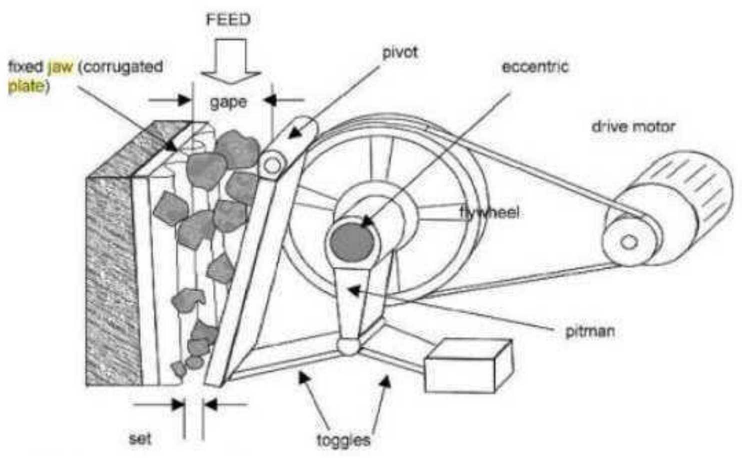


FIG 1: SINGLE TOGGLE JAW CRUSHER.

TABLE 1
SPECIFICATIONS OF SINGLE TOGGLE JAW CRUSHER WITHOUT STIFFENERS

S.NO	PARAMETER	VALUE
1	LENGTH OF THE JAW	1200(MM)
2	WIDTH OF THE JAW	900(MM)
3	THICKNESS OF THE JAW	215(MM)
4	LOAD	8700N

TABLE 2
SPECIFICATIONS OF SINGLE TOGGLE JAW CRUSHER WITH STIFFENERS

S.NO	PARAMETER	VALUE
1	Length of the jaw	1200(MM)
2	Width of the jaw	900(MM)
3	Thickness of the jaw	215(MM)
4	Height of stiffeners	50 (MM)
5	Width of stiffeners	50 (MM)
	Load	8700N

II. DESIGN OF JAW PLATES

Recently, concern for energy consumption in crushing has led to the consideration of decreasing the weight (and consequently the stiffness) of the swing plate of jaw crushers to match the strength of the rock being crushed. An investigation of the energy saving of plate rock interaction when point load deformability and failure relationships of the rock are employed to calculate plate stresses. In order to conduct this investigation, a model has been created in the modeling software PROE and then with the help of finite element analysis software ANSYS analysis it. The model is made firstly without stiffeners and analyzed then for further analysis numbers of stiffeners are added in the model and again it analyzed.

2.1 2D Model of Single Toggle Jaw Crusher

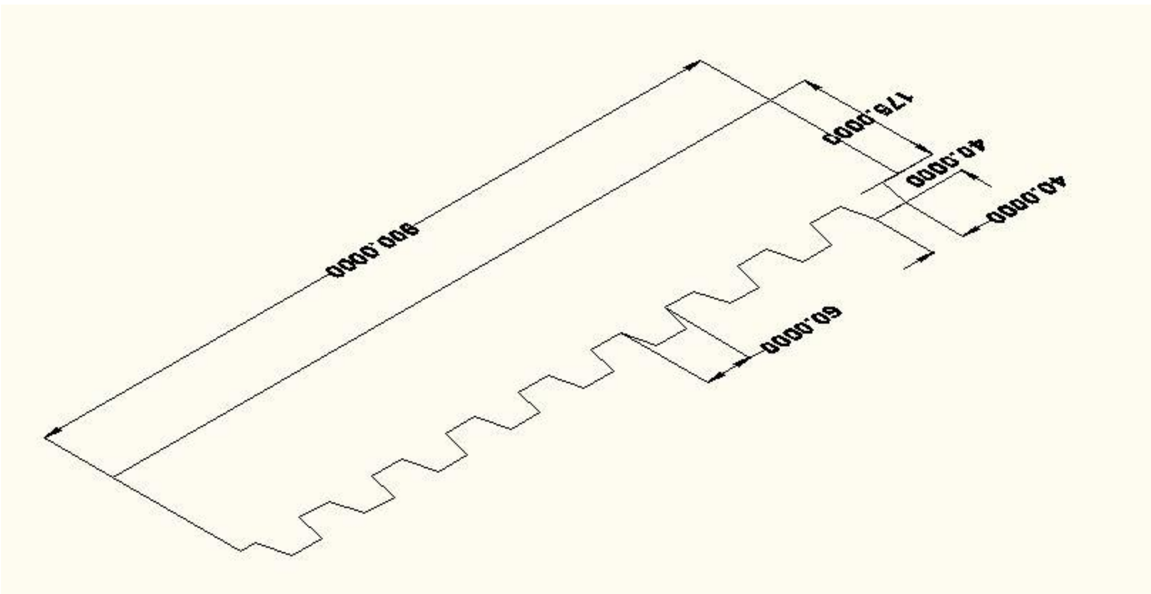


FIG 2: CORRUGATED JAW CRUSHER 2D MODEL

2.2 Solid Modeling of Corrugated Swing Jaw Plate Using proe

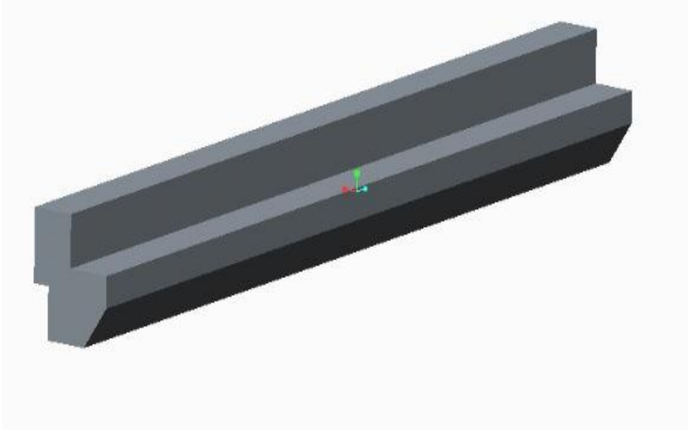
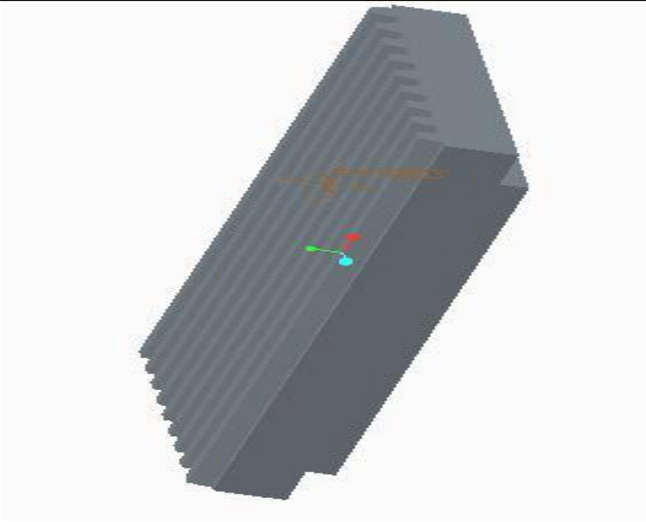
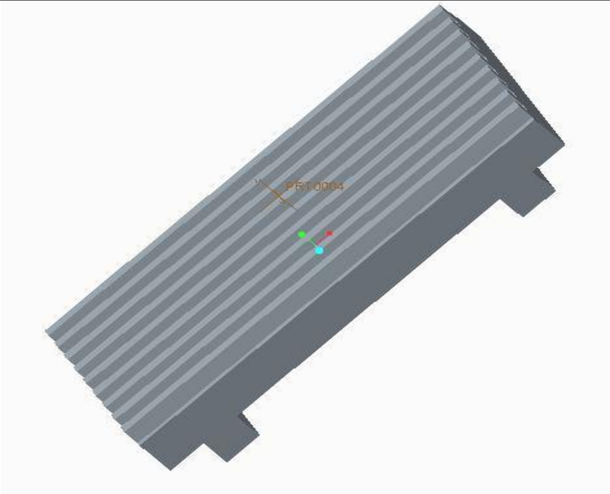
	

FIG 3: BOTTOM SUPPORT FOR THE JAW CRUSHER	**FIG 4: CORRUGATED JAW CRUSHER WITHOUT STIFFENERS**
	
FIG 5: CORRUGATED JAW CRUSHER WITH ONE STIFFENERS	**FIG 6: CORRUGATED JAW CRUSHER WITH TWO STIFFENERS**

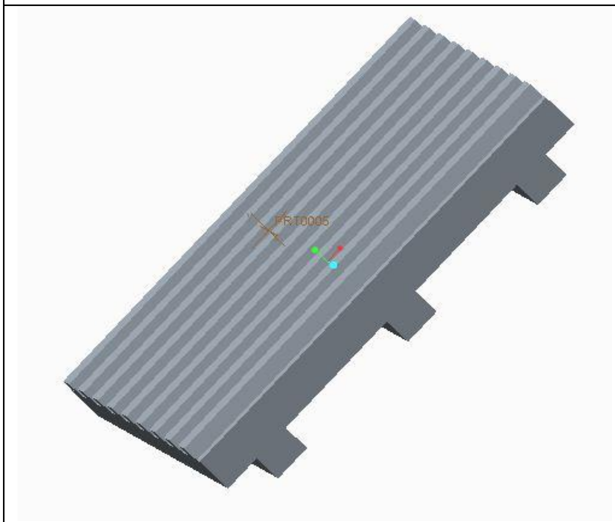
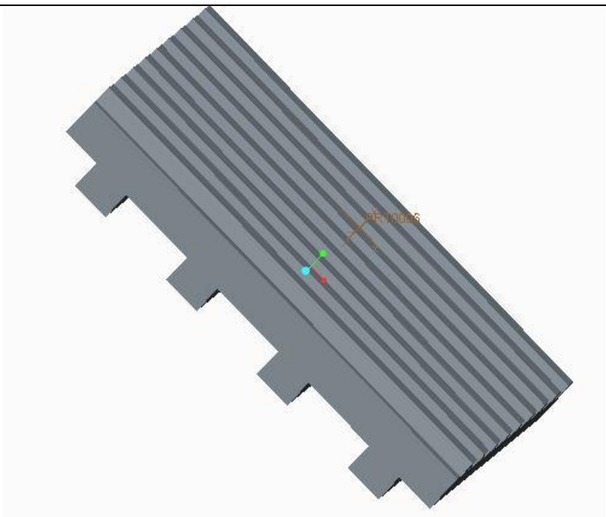

	

FIG 7: CORRUGATED JAW CRUSHER WITH THREE STIFFENERS	**FIG 8: CORRUGATED JAW CRUSHER WITH FOUR STIFFENERS**

2.3 Solid Modeling of Curved Swing Jaw Plate Using Proe

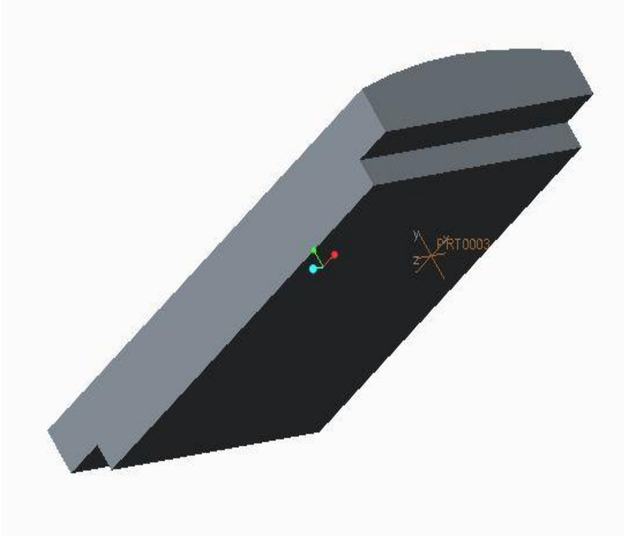


FIG 9: CURVED JAW CRUSHER WITHOUT STIFFENERS

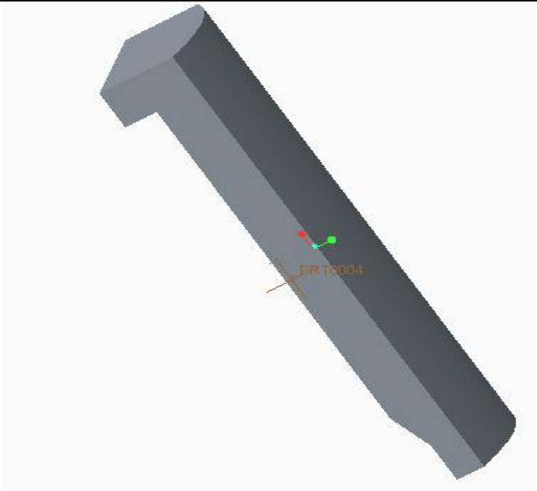


FIG 10: CURVED JAW CRUSHER WITH ONE STIFFENER

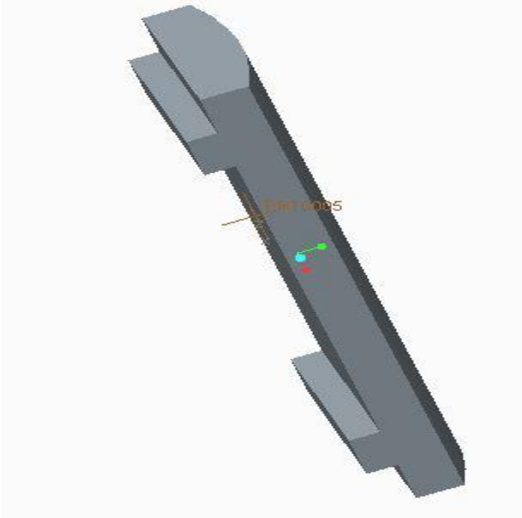


FIG 11: CURVED JAW CRUSHER WITH TWO STIFFENERS

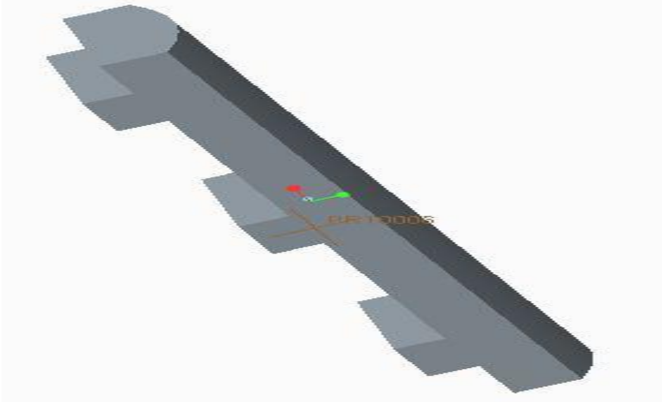


FIG 12: CURVED JAW CRUSHER WITH THREE STIFFENERS

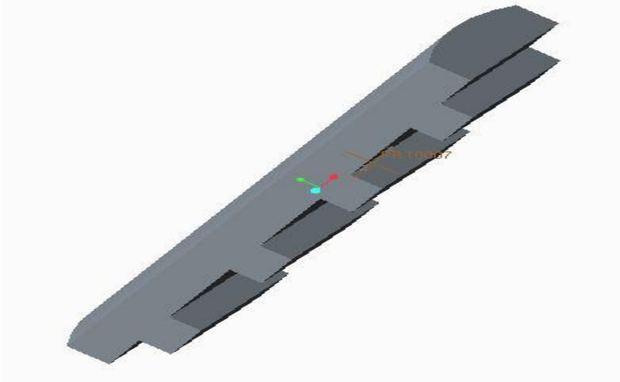


FIG 13: CURVED JAW CRUSHER WITH FOUR STIFFENERS

III. SWING JAW PLATES STATIC STRUCTURAL ANALYSIS USING ANSYS (MANGANESE STEEL)

3.1 Assumptions

Analysis was undertaken based on the assumption that the point load strength of the disk and irregularly shaped particles to be equal and tensile point loads of different particle sizes are acting normal to the plate. For the analysis of the of swing jaw plate, the model of the swing jaw plate is converted into STEP file and then this file is called for the analysis

3.2 Applying Material

Before the Structural Analysis module used for the FEA model, it must have material assigned to it. Each material in ANSYS has mechanical properties for computing the analysis for different materials but it has a facility to edits and add some material properties for other parts.

TABLE 3
PROPERTIES OF MANGANESE STEEL

PROPERTIES	VALUE
Density	7838 KG/MM^3
Elastic modulus	$210*10^3$ MPA
Shear modulus	$80.76*10^3$ MPA
Poisons ratio	0.3
Yield strength	550 MPA

3.3 Apply Boundary Conditions

Boundary condition for Swing jaw plate is simply supported i.e. the support at bearing location hinge support and at the free end toggle force acting. Due to which this plate is acts as a simply supported, figure shows the fixed point of plate. Fig showing Swing Jaw Plate Model Boundary Condition.

3.3.1 Applying Meshing

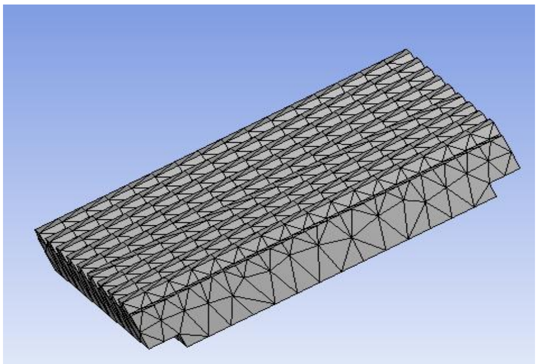


FIG 14: SHOWING JAW CRUSHER MESHING

3.3.2 Applying Supports

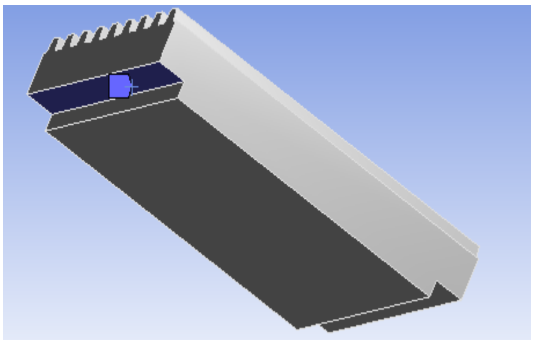


FIG 15: SHOWING JAW CRUSHER FIXED SUPPORT

3.3.3 Applying Loads

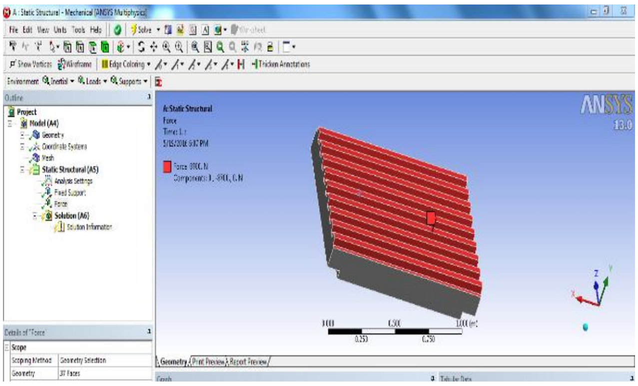


FIG 15: SHOWING APPLYING LOADS ON JAW CRUSHER

3.3.4 Linear Static Stress Analysis

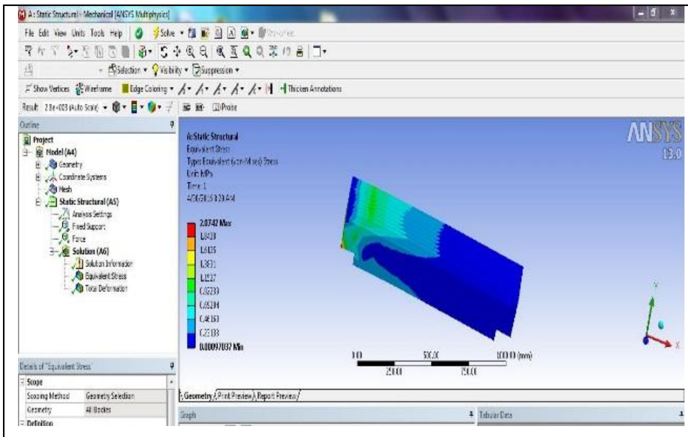


FIG 16: SHOWING SWING JAW PLATE STRESS ANALYSIS

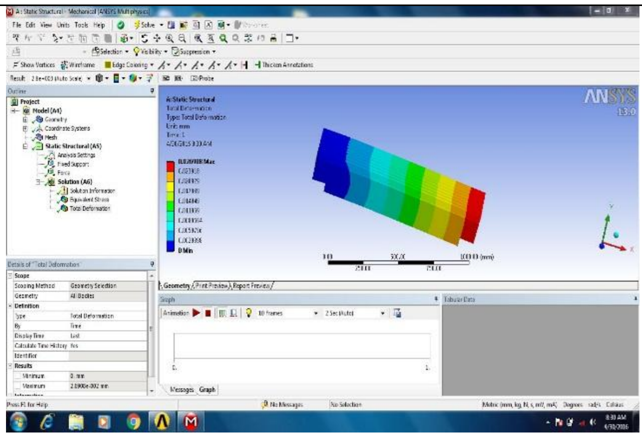


FIG 17: SHOWING SWING JAW PLATE DISPLACEMENT

3.4 Swing Jaw Plates Static Structural Analysis Using ANSYS (E Glass/ Epoxy)

3.4.1 Applying Material

TABLE 4
PROPERTIES OF E GLASS/EPOXY

Properties	Value
MASS DENSITY	$2.6*10^6$ KG/MM^3
TENSILE MODULUS ALONG X DIRECTION	*34000 MPA*
TENSILE MODULUS ALONG Y DIRECTION	*6530 MPA*
TENSILE MODULUS ALONG Z DIRECTION	*6530 MPA*
SHEAR MODULUS ALONG X DIRECTION	*2433 MPA*
SHEAR MODULUS ALONG Y DIRECTION	*1698 MPA*
SHEAR MODULUS ALONG Y DIRECTION	*2433 MPA*
POISSONS RATIO ALOG XY DIRECTION	*0.217*
POISSONS RATIO ALOG YZ DIRECTION	*0.366*
POISSONS RATIO ALOG ZX DIRECTION	*0.217*

3.4.2 Applying Meshing

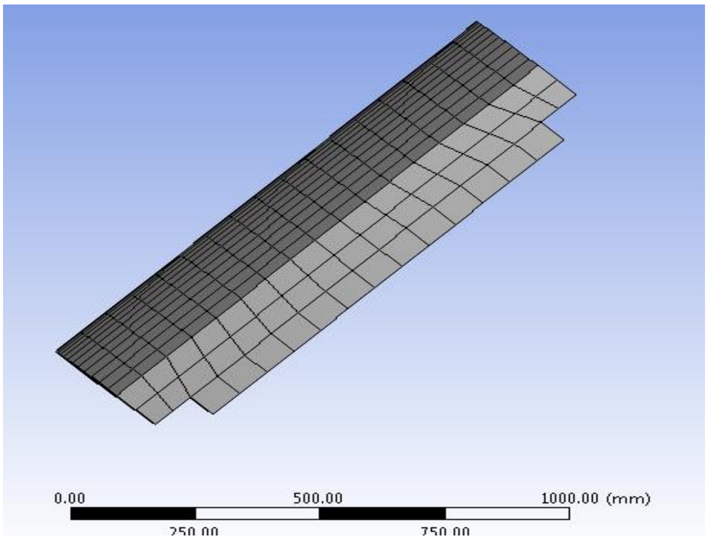


FIG 18: JAW CRUSHER MESHING

3.4.3 Applying Supports

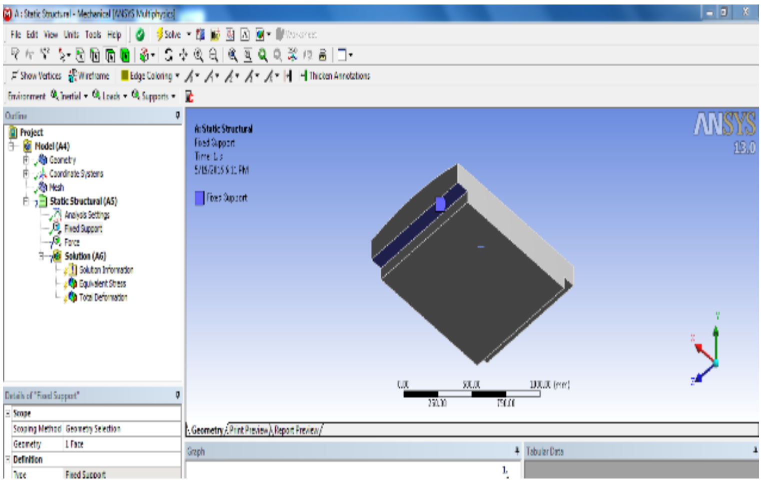


FIG 17: SHOWING JAW CRUSHER SUPPORT

3.4.4 Applying Loads

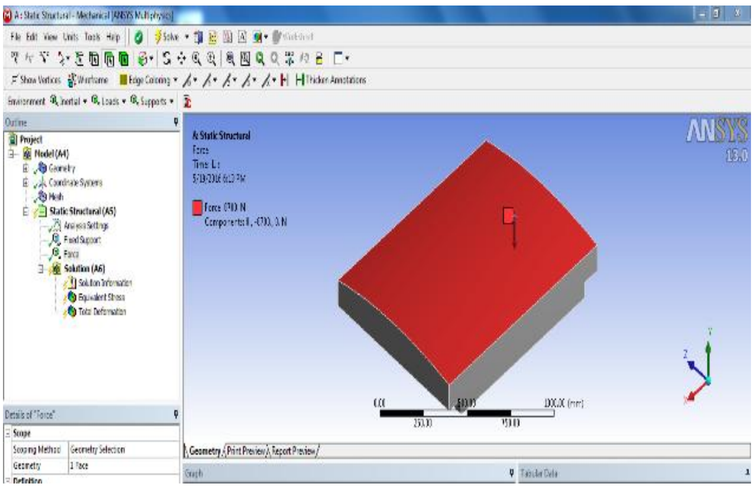


FIG 18: SHOWING SWING JAW PLATE LOAD

3.4.5 Linear Static Stress Analysis

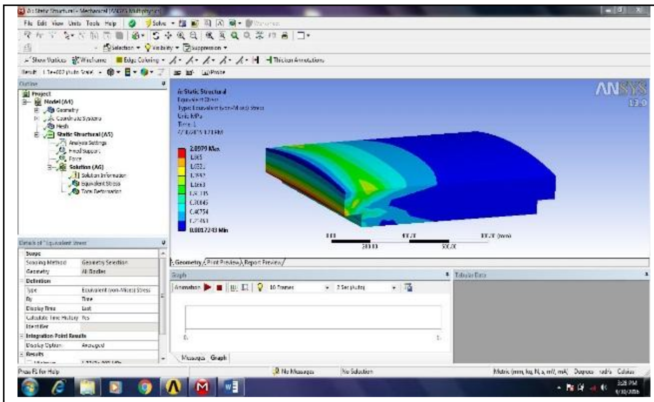


FIG 19: SHOWING SWING JAW PLATE STRESS ANALYSIS

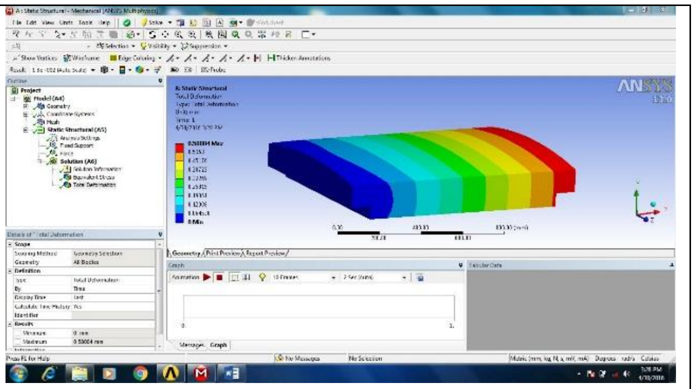


FIG 20: SHOWING SWING JAW PLATE DISPLACEMENT

IV. RESULTS

FEA models using ANSYS are employed to calculate maximum tensile stresses for the jaw crusher. By using E-glass/Epoxy we can reduce weight of the jaw crusher up to 66.82%.

TABLE 5

CORRUGATED JAW MANGANESE STEEL STATIC STRUCTURAL ANALYSIS

No Of Stiffer	Von mess stress (MPA)	TOTAL DEFORMATION (mm)	Weight of jaw (KG)
0	2.0742	0.026908	1580.1
1	2.8917	0.082075	1024.6
2	2.2182	0.053149	1121.6
3	2.2151	0.052376	1174.5
4	2.2415	0.051505	1227.4

TABLE 6

CORRUGATED JAW E GLASS/EPOXY STRUCTURAL ANALYSIS

No Of Stiffer	Von mess stress (MPA)	TOTAL DEFORMATION (mm)	Weight of jaw (KG)
0	2.1151	0.51669	524.16
1	2.8533	1.5304	339.88
2	2.2329	0.69842	372.06
3	2.255	0.69489	389.61
4	2.2651	0.69226	407.16

TABLE 7

CURVED JAW MANGANESE STEEL STATIC STRUCTURAL ANALYSIS

No Of stiffer	Von mess stress (MPA)	TOTAL DEFORMATION (mm)	Weight of jaw (KG)
0	2.1335	0.028723	1614.4
1	3.7328	0.080046	1088.1
2	2.2869	0.051472	1163.9
3	2.2779	0.050716	1231

TABLE8

CURVED JAW E GLASS/EPOXY STATIC STRUCTURAL ANALYSIS

No Of Stiffer	Von mess stress (MPA)	Total deformation (mm)	Weight of jaw (KG)
0	2.0979	0.58084	535.86
1	3.59392	1.533	360.95
2	2.1695	0.73357	386.1
3	2.1669	0.73421	408.33
4	2.0121	0.71836	425.88

V. CONCLUSION

From this we concluded that single toggle jaw crusher made by composite material will give better results regarding deformation and weight savings and stress and life the component compared to manganese steel. This is proved by analytically and FEA at 8700N for manganese steel and E glass/Epoxy composite material and also we made attempt for optimizing single toggle jaw crusher with multiple stiffeners and that FEA results are also included in results.

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