Modelling and Simulation of Swing Jaw Plate of Jaw Crusher Using Different Composites

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Abstract- Jaw crusher is a mechanical device which is used to crush large solids into smaller pieces. The performance of jaw crusher is dependent on material to be crushed and capacity of the crusher. Swing jaw plate is designed to crush hardest material without any failure on the other hand it consumes less power in short light weighted. Generally swing jaw plate assembly (plate and holder) made of steel which is heavy and consumes more power. Aim of this work is to reduce the weight of swing jaw plate assembly by using different composite material and compare with previous material and choose the best suitable composite material for jaw plate holder. For this CAD modeling of jaw plate assembly is done in CREO and structural analysis in ANSYS for using different composite material. Static analysis result shows composite material more safe than steel. Epoxy carbon fiber composite is less than steel. Hence for swing plate holder epoxy carbon fiber is replace the steel as a material and light weighted also because density of epoxy carbon fiber is less than steel.

Index Terms-Swing jaw plate, Composite material, Static analysis, Equivalent stress, total deformation, safety factor and weight.

I. INTRODUCTION

Jaw crusher is a device which is used to crush the large material into smaller pieces using the power delivered by the motor. In jaw crusher feed is trapped within the two jaws where it can crush by using the compressive force applied by jaw plate. In jaw crusher two sets of jaw plate first is fixed and other one is movable which is hinged to the shaft. Swing jaw plate provides a to and fro motion with respect to fixed plate and crushes the material. 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. Crushing plate is strong enough to crush hardest material hence this study based on crusher plate and its strength. By using composite material as holder material for decrease the weight of the plate assembly.

II. MATERIAL AND METHOD

The material which is composed of two or more different kinds of composite which are insoluble in each other and maintain their physical and chemically separated by clear cut interface called composite.

- Low density
- High specific strength
- High thermal conductivity
- Good fatigue modulus
- High abrasion

For this work choose five types of composite material which is near to the steel in physical and mechanical properties.

- Epoxy carbon fiber reinforced composite
- Epoxy fiber glass composite
- Fiber reinforced aluminum
- Cast iron Marten site

III. CAD MODELING OF JAW PLATE ASSEMBLY

First we creating jaw plate in CREO, using part file and unit setup were in metric system, the length of plate is 1200mm, width of the plate is 900 mm and thickness is 140 mm in fig 3.1

Fig 3.1 Jaw plate
Creating swing jaw holder using part file. The dimension for swing jaw plate are defined as per the measurement of actual model used in industry in fig 3.2

![Fig 3.2 Jaw Holder](image1)

![Fig 3.3 Swing jaw plate assembly](image2)

First importing swing jaw holder part in assembly

IV. STRUCTURAL ANALYSIS OF SWING JAW PLATE ASSEMBLY

A. First import the geometry from the file folder saved in IGES format.

B. Second assign the material of each of the component in this plate as a steel and holder is composite material.

C. **Meshing**- Meshing of the jaw crusher model is done after defining the material properties and assigning each material to each of the component. Tetrahedral element is used for all the components of jaw crusher. Tetrahedral element better approximate the shape with minimum error as compared to brick element shown in fig 3.4.

**Boundary Condition**- Hinged support at upper face of the assembly, force is applied in the jaw assembly model. 8700 N in the face of the plate and toggle force applied in the back side of the holder shown in fig 3.5

1. Both plate and holder is made of Martensite steel

![Fig 3.5](image3)

![Fig 3.6](image4)
2. Holder made of Epoxy fiber glass composite

3. Holder made of Epoxy carbon fiber composites

4. Holder made of Fiber reinforced aluminum

**F. EXPERIMENTAL SETUP**

<table>
<thead>
<tr>
<th>S. R. N. O.</th>
<th>COMPO SITES</th>
<th>DENS ITY (Kg m⁻³)</th>
<th>YOUNG’S MODULUS (MPa)</th>
<th>SHEAR MODULUS (MPa)</th>
<th>TENSILE STRENGTH (MPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CAST IRON</td>
<td>7250</td>
<td>1.47E+05</td>
<td>5.711E+10</td>
<td>411</td>
</tr>
<tr>
<td>2</td>
<td>EPOXY FIBER GLASS</td>
<td>1850</td>
<td>9650</td>
<td>75800</td>
<td>920</td>
</tr>
<tr>
<td>3</td>
<td>EPOXY CARBON FIBER</td>
<td>1470</td>
<td>10500</td>
<td>3830</td>
<td>1080</td>
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<tr>
<td>4</td>
<td>FIBER REINFORCED ALUMINIUM</td>
<td>3320</td>
<td>2.07E+05</td>
<td>8.1496 E+10</td>
<td>1050</td>
</tr>
<tr>
<td>5</td>
<td>MARTEN SITE</td>
<td>7720</td>
<td>1.98E+05</td>
<td>7.7404 E+10</td>
<td>91 7</td>
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</table>
V. RESULT AND DISCUSSION -
After taking of all possible material result shows steel as a holder material generate more stress compare to composite material and deformation also more than the composite material. Analysis shows the result that Epoxy carbon fiber deformation and equivalent stress both are less than steel and also other composite material (Epoxy fiber glass, fiber reinforced aluminum and cast iron)

Table 5.1 Static analysis result

<table>
<thead>
<tr>
<th>S.N</th>
<th>Material</th>
<th>Load (N)</th>
<th>Jaw plate</th>
<th>Total Deformation (mm)</th>
<th>Equivalent stress (MPa)</th>
<th>Weight (T)</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Marten site steel</td>
<td>8700</td>
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<td>0.1894</td>
<td>42.43</td>
<td>3.8678</td>
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<tr>
<td>3</td>
<td>Epoxy carbon fiber composites</td>
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<td>0.3865</td>
<td>61.55</td>
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<td>4</td>
<td>Cast iron</td>
<td>8700</td>
<td>0</td>
<td>0.200117</td>
<td>104.19</td>
<td>3.62052</td>
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<tr>
<td>5</td>
<td>Fiber reinforced aluminum composite</td>
<td>8700</td>
<td></td>
<td>0.1863</td>
<td>42.008</td>
<td>2.3811</td>
</tr>
</tbody>
</table>

VI. CONCLUSION
The static analysis is performed for several composite materials like epoxy fiber glass, epoxy carbon fiber, fiber reinforced aluminum. These materials which can replace the steel as a holder material of jaw crusher. Suggested material is epoxy carbon fiber because the value of von misses
is more as steel but the deformation is less than the steel.

VII. REFERENCES


