Analysis and modeling of pickaxe

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Abstract

Pickaxe is a common labor working tool used for digging purpose. The analysis of existing pickaxe can give idea to modify the design to increase worker performance and productivity. This paper presents the Modelling of existing pickaxe in Solid Works and Analysis of existing pickaxe in Cosmos Works. It consists of all the steps used for modeling and analysis of pickaxe. The FEM analysis shows the static distribution of stress and strain in different sections of existing pickaxe. It also shows the material property and static displacement distribution of different sections of pickaxe.

Keywords: Finite Element Method, Pickaxe, Ergonomic, Analysis, Design.

1. Introduction

A tool Pickaxe used almost universally for digging and other labouring work where there may be scope for improvements in conventional pickaxe design.

Ergonomics has many aspects, one of which is anthropometry, which address posture analysis to reduced worker stress, fatigue and injuries. At the same time, attention to details such as these has the potential to increase worker performance and productivity. Those factors underpin the current analysis of the hand operated Pickaxe. Pickaxe is a manually operated common hand tool used for digging and in nursery bed preparation. A pickaxe (or pickax) is a hand tool with a hard head attached perpendicular to the handle. It has a head with a pointed end and a flat end, and a pick has both ends pointed, and only one end. The head is usually made of metal, and the handle is most commonly wood, metal or fiberglass. Its shape is developed by forging operation. These tools are available in different shapes and size. For operation the handle of the pickaxe is held in the hand, head rise and struck into the soil for digging.

Mechanical evaluation consists of design and finite element analysis of agricultural hand tool with the help of FEM design and analysis software like Solid Works and Cosmos Works. The method, which gives better field capacity, less power consumption, low energy expenditure rate and more safety will be recommended to be used in the agricultural operation.

Specifications of existing Pickaxe are specified by their types and weight:

- Weight (kg) : 2.5
- Chisel end length (cm) : 23
- Sharp end length (cm) : 23
- Uses : Digging, loosing of earth, making of trenches and nursery

bed operation.

Figure: 1. Existing Pickaxe

The head is a spike ending in a sharp point, may curve slightly, and often has a counter-weight to improve ease of use. The stronger the spike, the more effectively the tool can pierce the surface. Rocking the embedded spike about and removing it can then break up the surface. The counterweight nowadays is nearly always a second spike, often with a flat end for prying.

The pointed edge is most often used to break up rocky surfaces or other hard surfaces such as concrete or hardened dried earth. The large momentum of a heavy pickaxe, combined with the small contact area, makes it very effective for this purpose. The chiseled end, if present, is used for purposes including cutting through roots.

2. Objective

The aim of this paper is to Modelling of existing pickaxe in SolidWorks and Analysis of existing pickaxe in Cosmos Works.

3. Modeling and Analysis of Pickaxe

Modeling and analysis of a pickaxe can be divided into two parts. Tool modeling in SolidWorks and Analysis of pickaxe with Cosmosworks. The steps involve in modeling and analysis is described below.

3.1 Procedure for Creating SolidWorks CAD Model of a 2-D Part:

1. Open SolidWorks 2008
2. File>New>Part>OK
3. Make sure units for the part are in centimeter

a. To verify what unit system is being used, click on

Tools>Options>Document Properties tab>Units (in the tree) and verify

that “Linear Units” are in centimeter.

4. Click on “Front” plane in model tree

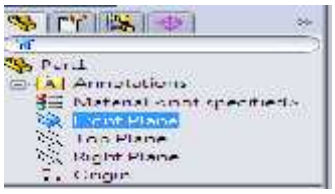

Figure: 2 SolidWorks model tree window

5. Click on “Sketch” icon (upper right-hand corner)

6. Sketch part

a. Use lines, arcs, etc. (icons found on right-hand side of window)

b. Dimension the sketch appropriately using the dimension icon 

i. Lines in the sketch will turn black (initially blue) when fully dimensioned

c. When finished, click on the sketch icon with the arrow in the upper right-hand corner of the sketch window 

7. Extrude and loft the sketch to create a 3-D model of the pickaxe design

8. Save the part to file

a. File>Save As…> part name (Pickaxe.SLDPRT)

The final model developed in SolidWorks is shown below:

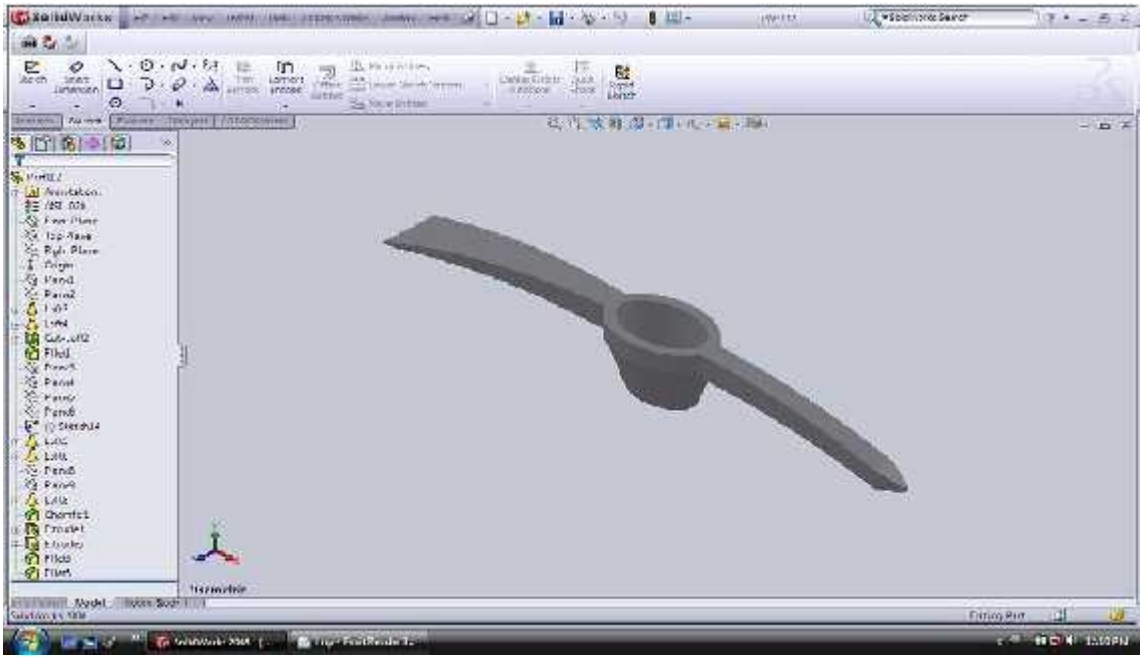

Figure: 3.Final modeling of Pickaxe in SolidWorks

3.2 Procedure for Cosmos Works Structural Analysis of Pickaxe:

1. Open Cosmos Works 2008
2. File>Open>part name. SLDPRT >OK
3. Click on “Cosmos Analysis Manager” tab at the right of the Feature Manager tree 
4. Right-click on the part in the Feature Manager tree and select “Study…”
5. Fill out Study dialog box

a. Type in a desired name for the study under “Study Name”

b. Select “Static” in the box under “Analysis Type”

c. Select “Solid mesh” in the box under “Mesh type”

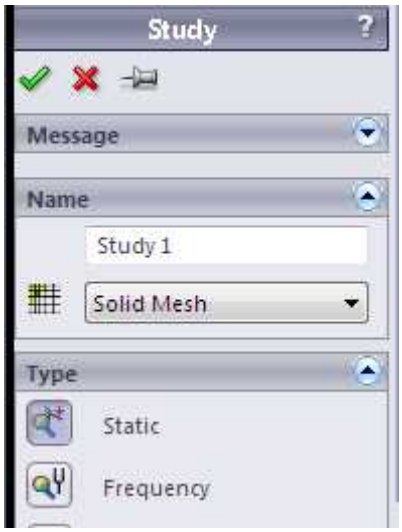

Figure: 4 Study dialog box

6. Set material properties for the part

    a. Right-click on the part name under “Solids” in the model tree

    b. Click on “Apply/Edit Material…”

    c. Make sure library file source is Coswkmat.lib

    d. In the material tree, open Cast Alloy Steel

    e. Make sure the “Type” under “Material model” is set to “Linear Elastic Isotropic”

    f. Click OK when finished

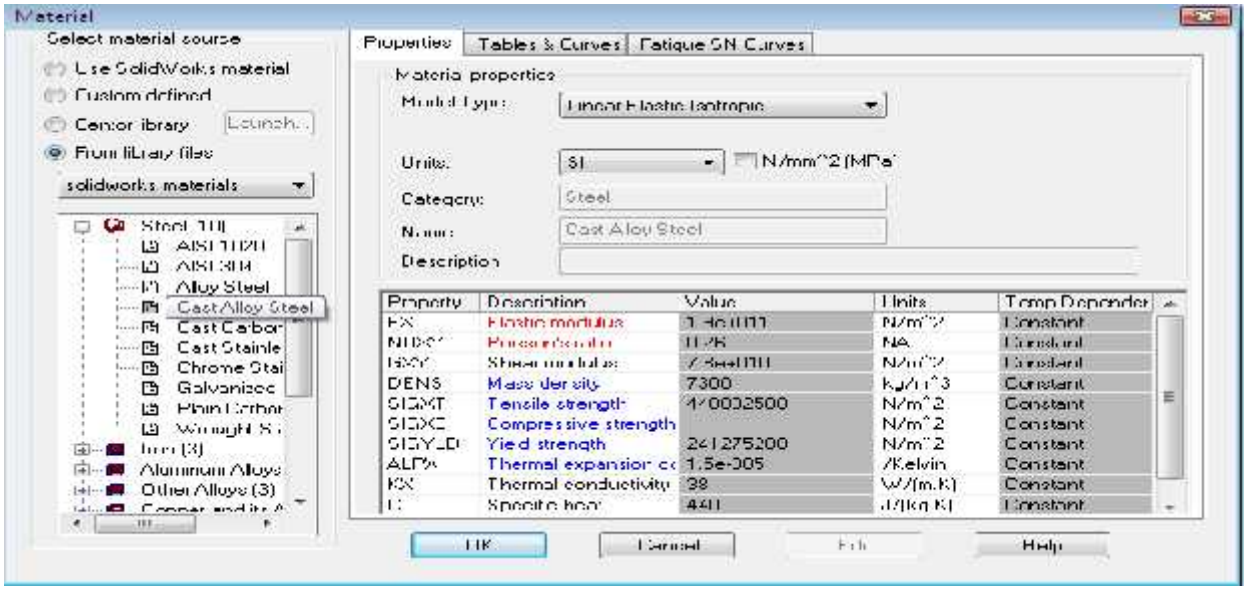

Figure: 5 Material Dialog Box

7. Define boundary conditions

a. Right-click on “Load/Restraint” in the tree

b. Select “Restraints”

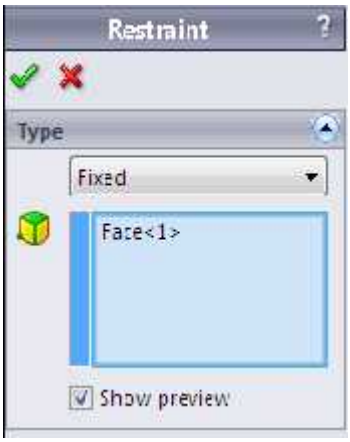

Figure: 6 Restraint dialog box

Figure: 7 Selection of restraint surface

8. Define loads in the model

a. Right-click on “Load/Restraint” in the tree

b. Select “Force”

c. Click on the surface at which to apply the load

d. Input the desired load magnitudes in the desired directions

e. Click the green check mark when finished

Figure: 8 Load/Restraint in model tree

Figure: 9 Force dialog box for load on Pickaxe

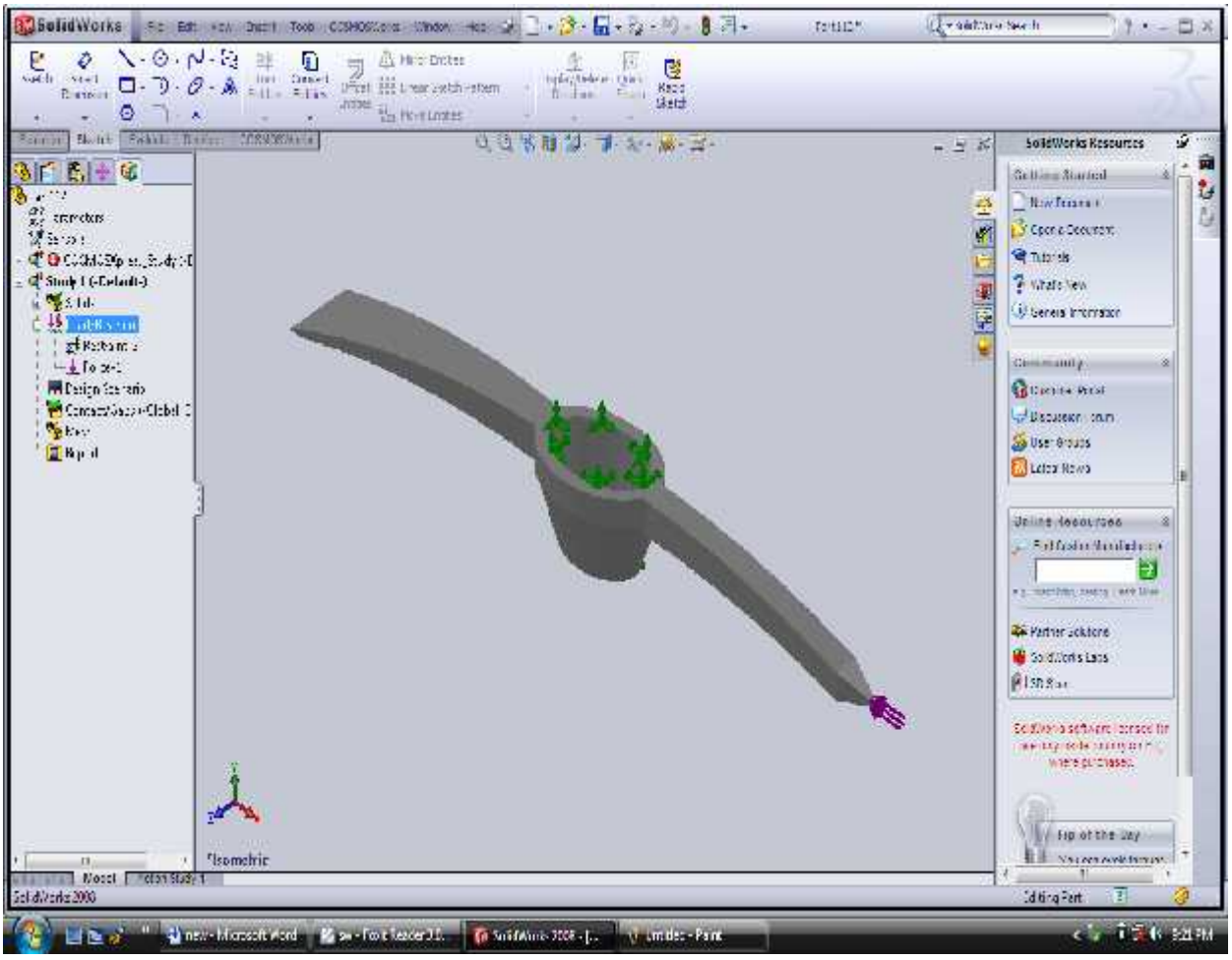

Figure: 10 Result of force and restraint definitions on Pickaxe

9. Create desired mesh on part to analyze

a. Right-click on “Mesh” in the tree and select “Create Mesh”

b. Edit mesh Options

i. Under “Mesh Quality,” select “High”

ii. Under “Mesher Type,” select “Standard”

iii. Set “Jacobian Check” to “4 Points”

iv. Click Apply

Figure: 11 Mesh Options dialog box

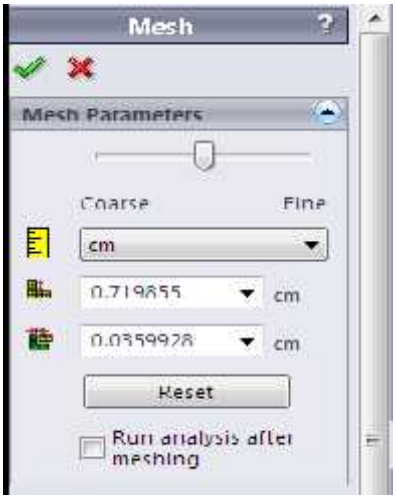

Figure: 12 Mesh properties dialog box

c. Create mesh

i. Right-click on “Mesh” in the tree and select “Create”

ii. “Mesh parameters” dialog box will appear

d. To display detailed information about the mesh, right-click “Mesh” in the tree and select “Details”

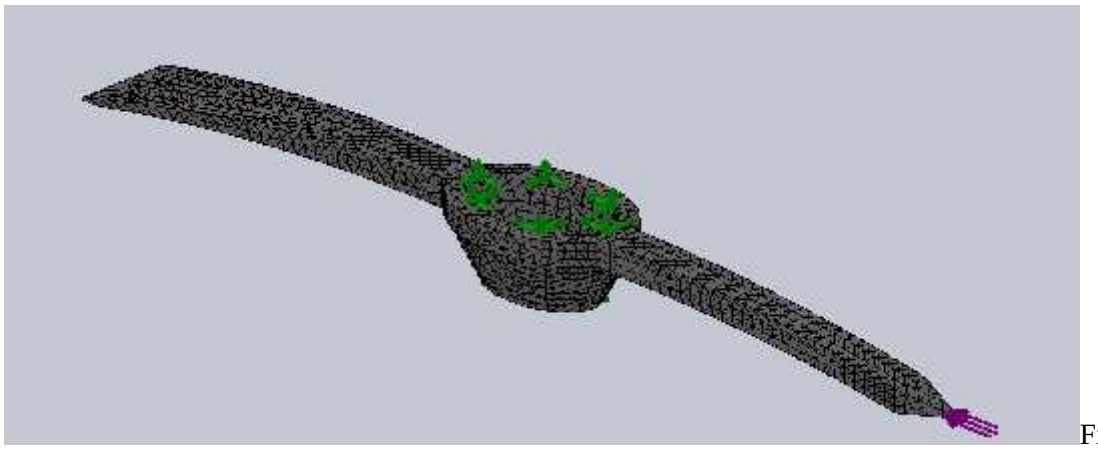

Figure: 13
Mesh result with restraints and loads displayed

10. Perform structural analysis

a. In the model tree, right-click on the study created and click “Run”

11. Display results of analysis

a. After analysis has been run, additional folders will appear in model tree

b. Display von Mises stress results

i. Click the plus sign beside the “Stress” folder ii. Double-click on “Plot1” and the stress plot is displayed

c. Display resultant displacement

i. Click the plus sign beside the “Displacement” folder

ii. Double-click on “Plot1” and the displacement plot is displayed

d. Display resultant Strain

i. Click the plus sign beside the “Strain” folder

ii. Double-click on “Plot1” and the Strain plot is displayed

4. Results

The finite element analysis of pickaxe shows the following results

- The property of pickaxe material can determine.
- Region of stress distribution in different sections can determine.
- Region of static strain distribution in different sections can determine.
- Region of static displacement distribution in different parts can determine.

5. Conclusion

The finite element analysis of pickaxe shows distribution of stress and strain in different sections of pickaxe. It also shows the material property and static displacement distribution of different sections of

pickaxe. When force is applied to the pointed end of pickaxe, stress and strain distribution near the hole is very low. Therefore the material near the hole can be removed for reducing weight, which makes the tool lighter, comfortable and easy handling for workers. The modification in pickaxe design can reduce the worker stress, fatigue and efforts in digging. This increases the workers performance and productivity.

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