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STUDY ON LOADER BUCKET USING FINITE ELEMENT ANALYSIS

Saisugun Dontha, *B. Tech, Department of mechanical engineering, Vidya Jyothi Institute of Technology, Hyderabad, Telangana, INDIA*

Abstract - *In general, the loader bucket is a scoop shaped heavy bucket fabricated with hardened material and heavy hydraulics. It is mounted in the front side of the excavator machine. Loader Bucket is mainly used in construction sites for multipurpose operations like shoveling, digging, lifting, loading and carrying materials. The main operations of bucket are accomplished by the bucket component i.e. bucket teeth acts with force for excavating, lifting and other operations. The inspiration for this work is to design a heavy loader bucket with all components and specifications in Solid works2016 designing software and to calculate the stresses and deformation on Loader bucket, forces and loads are applied on bucket to perform the Finite element analysis in ansys15.0. software.*

1.INTRODUCTION

Loader bucket is the main sub-assembled part of the excavator machine equipped with heavy hydraulics to the machined arms of the excavator. The arms of the excavator are controlled by the high powered hydraulic rams to attack, lift, dig and excavate the raw material with the loader bucket. Loader buckets are designed according to purpose of operation in various types such as backhoe loader, wheel loader, skid loader, mini loader and front end loader. In this modern earthmovers era the loader bucket teeth are very rigid and strongly fabricated to excavate the mines and they play a major role in any excavation operations. Various types of bucket teeth are manufactured such as long, penetration, wide and rock chisel. These bucket teeth are assembled on teeth adapters with bolts to hold tight and penetrate in to the raw material. These teeth assembly is either welded or mounted to the base edge of the loader bucket. When the loader bucket is in action bucket teeth may get deform due to heavy load. So, design of loader bucket is designed in solid works and the stresses and total deformation on loader bucket are calculated by finite element analysis.

2. PROBLEM FORMULATION

In this study the material used is AISI 1080 carbon steel having Carbon as the key alloying element which is very hard, strong and less ductile. 3D model of Loader bucket is designed in solid works software and loader bucket is analyzed by finite element analysis to determine the stresses and total deformation on loader bucket in ansys15.0. The material properties are as follows:

Table -1: Material properties of AISI 1080 carbon steel

Density	7.8 g/cm^3
Young's modulus	210GPa
Poisson's ratio	0.29
Tensile yield strength	590MPa
Tensile ultimate strength	890MPa

3.DESIGN MODEL OF LOADER BUCKET:

The 3D model of loader bucket is designed in solid works 2016 using sketching, boss-extrude, extruded cut and linear pattern tools. First the sketch is extruded to bucket and then linear patterned the bucket teeth as nine in number as shown in the Fig -1. Then this loader bucket part file is ready for Finite element analysis.

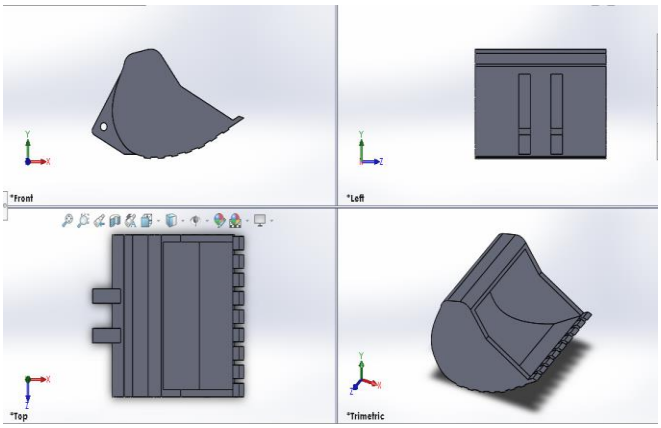

Fig -1: Design model of loader bucket

4.FINITE ELEMENT ANALYSIS OF LOADER BUCKET:

The Loader bucket part is designed in solid works 2016 designing software then converted for Finite element method analysis. In ansys workbench on left hand side select the Static Structural in Analysis systems and drag it to create a standalone system. In engineering data add a new material AISI 1080 carbon steel and its mechanical properties as given in the above table. Then the converted loader bucket part file to Geometry is imported for analysis. In model mesh is generated in tetrahedral type mesh which contains 9,486 nodes and 3,976 elements and the fixed supports and forces are given on loader bucket as shown in Fig - 2.

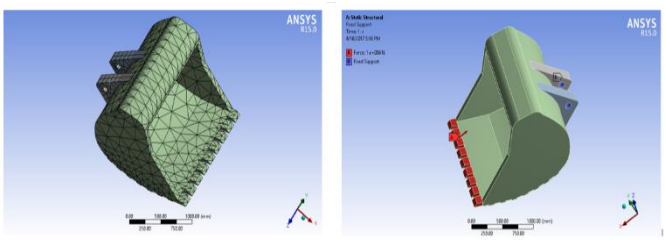

Fig -2: shows tetrahedral mesh type, fixed supports and forces

4.1 Case 1:

In this study the force at x- component is defined by components and the force applied is 1000000N in anti-clock wise direction. Fig - 3 shows the maximum Equivalent (Von-Mises) Stress value as 277.25MPa and the total deformation as 8.5331mm.

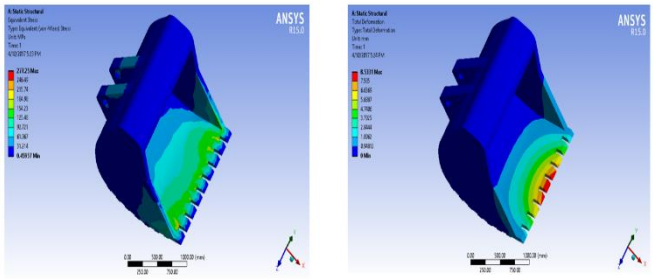

Fig - 3: The Equivalent (Von-Mises) Stress and total deformation (Case 1).

4.2 Case 2:

In this study the force at x- component is defined by components and the force applied is 1100000N in anti-clock wise direction. Fig - 4 shows the maximum Equivalent (Von-Mises) Stress value as 304.96MPa and the total deformation as 9.3864 mm.

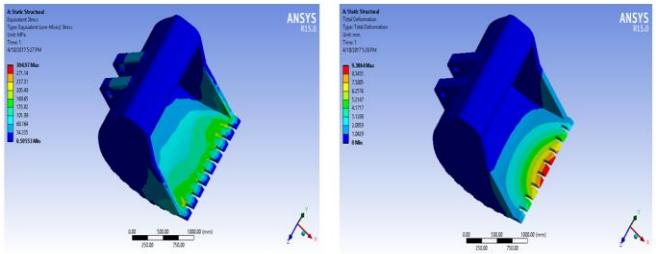

Fig -4: The Equivalent (Von-Mises) Stress and total deformation (Case 2).

4.3 Case 3:

In this study the force at x- component is defined by components and the force applied is 1200000N in anti-clock wise direction. Fig - 5 shows the maximum Equivalent (Von-Mises) Stress value as 332.69MPa and the total deformation as 10.24 mm.

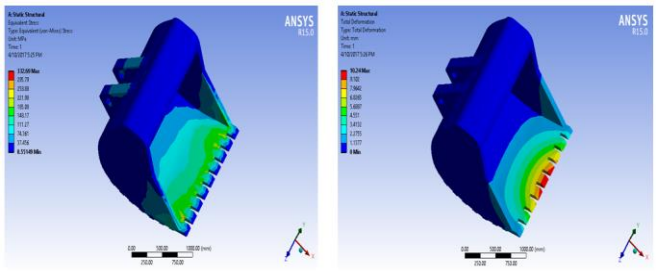

Fig -5: The Equivalent (Von-Mises) Stress and total deformation (Case 3).

5.RESULTS:

From the analysis the maximum stresses are generating on bucket teeth because bucket teeth come in contact to ground and material first in any excavations. The finite element analysis on Loader bucket shows the maximum and minimum Equivalent (Von-Mises) Stress and total deformation values in each case as follows

Table -1: Equivalent (Von-Mises) Stress and total deformation results

Serial No:	Analysis	maximum	minimum	Total deformation
1	Equivalent (Von-Mises) Stresses	277.25MPa	0.45957MPa	8.5331mm
2		304.96MPa	0.50553Mpa	9.3864mm
3		332.69MPa	0.55149MPa	10.24mm

6.CONCLUSIONS

In this paper the Loader bucket is designed in solid works2016 designing software and Finite element analysis is done in Ansys15.0. In three cases the Equivalent (Von-Mises) Stresses on the bucket teeth are 227.25MPa, 304.96 MPa and 332.69MPa. Total deformation in three cases is 8.5331mm, 9.3864mm and 10.24mm. From the above analysis it is found that design of loader bucket is very safe and the stresses generated are well below the Ultimate tensile strength (890MPa) of AISI 1080 carbon steel.

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