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Designing of an Excavator Bucket Using CATIA Software

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Abstract:

Excavator bucket life is the very important issue, because it fails to complete its designed life. The major reason behind this failure is its working environment and modes of operations. Excavator buckets are designed to work in worst conditions, situations for long duration of time. During its working bucket undergoes with great amount of stresses, loads, jerks, deformations and it would be very difficult to withstand in such situations. Hence the excavator bucket material is tough. However this selection is not sufficient for designed bucket life. In bucket observations, we found cracks and tear areas on buckets which failed during working. Excavator Bucket always undergoes the heavy loading conditions. Hence the life of bucket is less than the designed life span. It all happened only due to the vibrations and the heavy loading conditions. Deformation and stresses induced in bucket structure must be studied well so that the life of bucket can be improved. It can be done by conducting Load test by using CAE software. Now a day's CAE softwares are more reliable and giving more approximate results. The sudden jerks, stresses, deformations are usually accurse during working. Due to sudden jerks and impact with rocks or tough materials, vibrations induces. This vibrations are measured in the form of natural frequency of a bucket. Continuous impact of such vibration range may affect the bucket life. And hence the cracks can be developed which leads to failure of bucket. There is a particular range of frequency up to which bucket can withstand. But beyond that range bucket may fails. Hence the study of resonant frequency also an important aspect for excavator bucket.

Keywords **—**Load test, Vibration Analysis, ANSYS, CAE Tool, Natural Frequency, Shape Optimisation

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I. INTRODUCTION

A bucket (also called a scoop to qualify shallower designs of tools) is a specialized container attached to a machine, as compared to a bucket adapted for manual use by a human being. It is a bulk material handling component.The bucket has an inner volume as compared to other types of machine attachments like blades or shovels. The bucket could be attached to the lifting hook of a crane, at the end of the arm of an excavating machine, to the wires of a dragline excavator, to the arms of a power shovel or a tractor equipped with a backhoe loader or to a loader, or to a dredge. Excavator bucket is the important part which is responsible for work. It is used for digging, trolley felling, Heavy duty work etc. ANSYS is the original (and commonly used) name for ANSYS Mechanical or ANSYS Multiphysics, general-purpose finite element analysis software. ANSYS, Inc actually develops a complete range of CAE products, but is perhaps best known for ANSYS Mechanical & ANSYS Multiphysics. The academic versions of these commercial products are referred to as ANSYS Academic Research, ANSYS Academic Teaching Advanced, Introductory etc. All of these products are general purpose finite element self contained analysis tools incorporating preprocessing (geometry creation, meshing), solver and post processing modules in a unified graphical user interface (GUI). For the A bucket (also called a scoop to qualify shallower designs of tools) is a specialized container attached to a machine, as compared to a bucket adapted for manual use by a human being. It is a bulk material handling component.The bucket has an inner volume as compared to other types of machine attachments like blades or shovels. The bucket could be attached to the lifting hook of a crane, at the end of the arm of an excavating machine, to the wires of a dragline excavator, to the arms of a power shovel or a tractor equipped with a backhoe loader or to a loader, or to a dredge.Excavator bucket works in extreme conditions, hence in most of the cases excavator bucket fails before its designed life. Normally the bucket is designed for 7 years working. But due to heavy loading and continuous impact of forces bucket fails. By improving stiffness with addition on material at the stress concentrating areas, we can improve the life of bucket. If we go through the entire life of bucket then we will come to know with following facts.

LITERATURE REVIEW

The idea for Ansys was first conceived by John Swanson while working at the Westinghouse Astronuclear Laboratory in the 1960s. At the time, engineers performed finite element analysis (FEA) by hand. Westinghouse rejected Swanson's idea to automate FEA by developing general purpose engineering software, so Swanson left the company in 1969 to develop the software on his own. He founded Ansys under the name Swanson Analysis Systems Inc. (SASI) the next year, working out of his farmhouse in Pittsburgh. Swanson developed the initial Ansys software on punch-cards and used a mainframe computer that was rented by the hour. Westinghouse hired Swanson as a consultant, under the condition that any code he developed for Westinghouse could also be included in the Ansys product line. Westinghouse also became the first Ansys user. By 1991 SASI had 153 employees and $29 million in annual revenue, controlling 10 percent of the market for finite element analysis software. According to the engineeringdesign revolution, the company became "well-respected" among engineering circles, but remained small.In 1993, Mr. Swanson sold his majority interest in the company to venture capitalist firm TA Associates. Peter Smith was appointed CEOand SASI was renamed after the software, Ansys, the following year. Ansys went public in 1996, raising about $46 million in an initial public offering. By 1997, Ansys had grown to $50.5 million in annual revenue. In the late 1990s, Ansys shifted its business model. It focused less on selling software licenses and corresponding revenue declined. However, revenue from services increased more dramatically. From 1996 to 1999, profits at Ansys grew an average of 160 percent per year. In February 2000, Jim Cashman was appointed CEO. Current CEO Ajei S. Gopal was appointed in early 2017. The first commercial version of Ansys software was labeled version 2.0 and released in 1971. At the time, the software was made up of boxes of punch cards, and the program was typically run overnight to get results the following morning in 1975, non-linear and thermo-electric features were added. The software was exclusively used on mainframes, until version 3.0 (the second release) was introduced for the VAXstation in 1979. Version 3 had a command line interface like DOS. In 1980, apple II was released, allowing Ansys to convert to a graphical user interface in version 4 later that year. Version 4 of the Ansys software was easier to use and added features to simulate electromagnetism. In 1989, Ansys began working with Compuflo. Compuflo'sFlotran fluid dynamics software was integrated into Ansys by version 5, which was released in 1993. Performance improvements in version 5.1 shortened processing time two to four-fold, and was followed by a series of performance improvements to keep pace with advancements in computing. Ansys also began integrating its software with CAD software, such as Autodesk. In 1996, Ansys released the DesignSpace structural analysis software, the LS-DYNA crash and drop test simulation product, and the Ansys Computational Fluid Dynamics (CFD) simulator. Ansys also added parallel processing support for PCs with multiple processors. The educational product Ansys/ed was introduced in 1998. Version 6.0 of the main Ansys product was released in December 2001. Version 6.0 made large-scale modeling practical for the first time, but many users were frustrated by a new blue user interface. The interface was redone a few months later in 6.1. Version 8.0 introduced the Ansys multi-field solver, which allows users to simulate how multiple physics problems would interact with one another. Version 8.0 was published in 2005and introduced Ansys' fluid–structure interaction software, which simulates the effect structures and fluids have on one another Ansys also released its Probabilistic Design System and Design Xplorer software products, which both deal with probabilities and randomness of physical elements. In 2009 version 12 was released with an overhauled second version of Workbench. Ansys also began increasingly consolidating features into the Workbench software.

Version 15 of Ansys was released in 2014. It added a new features for composites, bolted connections, and better mesh tools. In February 2015, version 16 introduced the AIM physics engine and Electronics Desktop, which is for semiconductor design. The following year, version 17 introduced a new user interface and performance improvement for computing fluid dynamics problems. In January 2017, Ansys released version 18. Version 18 allowed users to collect real-world data from products and then incorporate that data into future simulations. The Ansys Application Builder, which allows engineers to build, use, and sell custom engineering tools, was also introduced with version 18. Released in January 2020, Ansys R1 2020 updates Ansys' simulation process and data management (SPDM), materials information and electromagnetics product offerings. In early 2020, the Ansys Academic Program surpassed one million student downloads.

In November 2020, South China Morning Post reported that Ansys software had been used for Chinese military research in the development of hypersonic missile technology.

AIMS AND OBJECTIVE RESEARCH

Aims:

i) Life improvement of excavator bucket by performing different CAE analysis.
ii) Stress Analysis to find the possible deformation and stress concentrated areas.
iii) Vibration/modal analysis of bucket for obtaining natural frequency value.
iv) Shape optimization of Modified Excavator Bucket.
v) Redesigning of bucket.

Objectives:

i) Comparisons of existing bucket and modified bucket.
ii) Analysis of modified and optimized bucket.
iii) Tabulated data formation for three different loading conditions.
iv) Conclusion on the basis of obtained CAE results.

Modelling of Excavator Bucket

CAD is an important industrial art extensively used in many applications, including automotive, shipbuilding, and aerospace industries, industrial and architectural design, prosthetics, and many more. CAD is also widely used to produce computer animation for special effects in movies, advertising and technical manuals, often called DCC digital content creation. The modern ubiquity and power of computers means that even perfume bottles and shampoo dispensers are designed using techniques unheard of by engineers of the 1960s. Because of its enormous economic importance, CAD has been a major driving force for research in computational geometry, computer graphics (both hardware and software), and discrete differential geometry.

CATIA V5 R19 AS A MODELLING TOOL:

CATIA (computer-aided threedimensional interactive application) is a multi platform software suite for computer-aided design (CAD), computer aided manufacturing (CAM), computer aided engineering (CAE), PLM and 3D, developed by the French company Dassault Systems. Commonly referred to as a 3D Product Lifecycle Management software suite, CATIA supports multiple stages of product development (CAX), including conceptualization, design (CAD), engineering (CAE) and manufacturing (CAM). CATIA facilitates collaborative engineering across disciplines around its 3DEXPERIENCE platform, including surfacing & shape design, electrical, fluid and electronic systems design, mechanical engineering and systems engineering. CATIA facilitates the design of electronic, electrical, and distributed systems such as fluid and HVAC systems, all the way to the production of documentation for manufacturing.

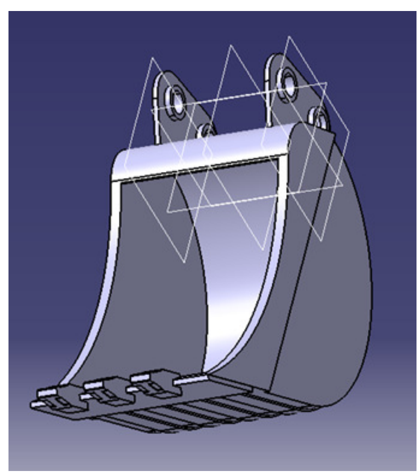

Fig: 3D CAD model Excavator Bucket

Modules used in Modelling:

- **Sketcher Module:**

The Sketcher workbench is a set of tools that helps you create and constrain 2D geometries. Features (pads, pockets, shafts, etc...) may then be created solids or modifications to solids using these 2D profiles. You can access the Sketcher workbench in many ways. Two simple ways are by using the top pull down menu (Start – Mechanical Design – Sketcher), or by selecting the Sketcher icon. When you enter the sketcher, CATIA requires that you choose a plane to sketch on. You can choose this plane either before or after you select the Sketcher icon. To exit the sketcher, select the Exit Workbench icon. The Sketcher workbench contains the following standard workbench specific toolbars.

- **POCKET command:**

The POCKET commands somehow the opposite of PAD command. It simply helps remove geometry belonging to an already create part. On the figure below the POCKET command is helping to create the cylinder hole in the middle of the cube.

- **SHAFT command:**

It is Like revolve command in other CAD software, the SHAFT command is mostly used to make shaft like parts. It requires an axis, around which the sketch will be revolved.

- **RIB command:**

This command which is usually known as SWEEP is called RIB IN CATIA. It adds material along a guide curve. RIB is used to make components like springs, pipes etc.

- **SLOT command:**

SLOT removes the material along a guide curve. Here is an example of slot. While using SLOT, I have used the same guide curve that was used for RIB. This ensures that the cross section will be uniform throughout.

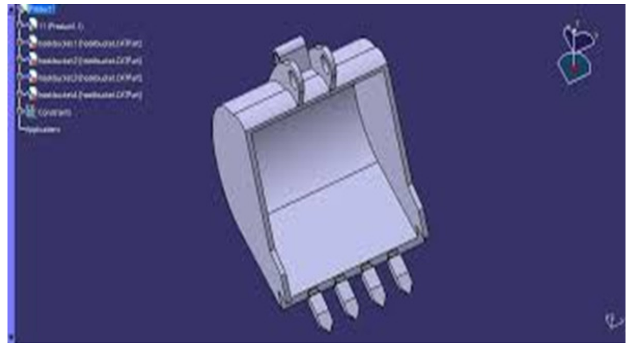

Fig: Geometrical model of Excavator bucket using CATIA

CONCLUSIONS:

We have studied design of Excavator bucket by using CATIA V5 software, the main objective of this study is designing excavator bucket and study disigning of excavator bucket.

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