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Design & experimentation of loader Shovel tooth by using various materials

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ABSTRACT

The earth moving equipment like excavators, loaders, haulers, etc. are commonly used in construction and mining industries. The loader tooth is one such part exposed to harsh working conditions. The work equipment portion of a hydraulic loader consists of hydraulic cylinders, a boom, an arm, and a bucket. Penetration force into the material is excavated by the arm cylinder and the bucket cylinder. To check the strength of shovel teeth for safer working conditions they are subjected to high load.

The objective of work is to improve the service life of excavator bucket teeth in order to decrease the ideal time required to reinstate the teeth periodically during excavation. Generally alloy steel is used to make an excavator bucket tooth and hard facing of some wear resistant materials can be applied on the material of bucket teeth, so that its life will improve against abrasive wear. When properly integrated into the product and manufacturing development, CAE can enable resolution earlier problem, which can reduce the costs associated with the product existence cycle. While the invention of tooth and due to which the collapse time decreased and increased performance. With the help of the Hyper Mesh FEM model shall be built as a pre-processor while the preferred solver identified in this work is RADIOSS for handling the analysis pertaining to impact loads of a dynamic life. This work results between experimentation and FEM software analysis are compared and evaluated. In this working maximum stress induced in shovel tooth is determined. This work helps to design reliable tooth which also useful in improving the life of the tooth which is a major problem in designing the tooth. With the help of Charpy V-notch impact test machine and FEM strain energy is recorded.

Keywords— Excavator tooth, FEA Tool, Impact Test, RADIOSS, Structural analysis.

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I. INTRODUCTION

Rapidly growing rate of earth moving equipment of industry is assured throught the high performance construction machineries with complex mechanism and automation of construction activity. Hydraulic system is used for operation of the machine while digging or moving the material. Aloader is comprised of two planar implements connected through revolute joints known as the arm, and bucket, and one vertical revoluteJoint known as the swing joint. A combination of extensions and retractions of the hydraulic cylinders.Generates the required motion of the components for digging. The hydraulic cylinder simultaneously provides the digging forces to be generated at the bucket tip. The pressure to be developed is generated by the hydraulic pump coupled to the engine. . In this thesis the analysis of characteristics of in volume spur gears in gearbox is intended for the study by using the FEM. Good, sharp bucket teeth are essential for ground penetration, enabling your excavator to dig with the least possible effort, and hence the best efficiency. Generally grey cast iron in the different grade material are used for shovel tooth analysis and compare chart. Using blunt teeth greatly increases the percussive shock transmitted through the bucket to the digging arm, and hence also to the slew ring and undercarriage, as well as ultimately using more fuel per cubic meter of earth shifted.

Benefits CAE using software:

Design decisions can be made based on their impact on performance.

Designs can be evaluated and refined using computer simulations rather than physical prototype testing, saving money and time.

CAE can provide performance insights earlier in the development process, when design changes are less expensive to make.

Problem Definition

The process of loading or digging is repetitive in nature and during operation entire link mechanism working under the dynamical condition. The resistive forces coming on the loader mechanism while filling the bucket (or shovel) are the functions of the shape of the terrain, soil and tool parameters, and the controller that joints using force feedback. So to design the loader mechanism for reliability under unpredictable workingconditions; all of this force need to be considered.

II. RELEVANCE, PRESENT THEORY AND PRACTICES

The earth moving equipment loader tooth is one such part exposed to harsh working conditions. The tooth is expected to bear the impact loading while the tiller hits the ground with a velocity of about 2m/sec while the ground is excavated to remove the soil during construction work or while trying to break the structure while bull-dozing the existing construction. Reaction loads of about half a ton are exerted on the tooth of the loader while it hits the ground with a to understand the background of the dissertation work, following research paper dealing with thistopic has been studied.

Bhaveshkumar et al [4]. The mini hydraulic backhoe excavator attachment is developed to perform excavation task for light duty construction work. Based on static force analysis finite element analysis is carried out for individual parts as well as the whole assembly of the backhoe excavator with and without consideration of welding. It is clearly depicted that the stresses produced in the parts of the backhoe excavator attachment are within the safe limit of the material stresses for the case of with and without consideration of welding. The result shows the maximum stresses produced in the parts with welding is less than the parts without welding, it clearly depict that the welding strengthen the parts. Based on results also we can conclude that the maximum stresses produced in the parts are very less compare to limiting (safe) stress of the parts material, therefore there is a scope to perform the structural optimization of the excavator attachment for weight reduction.

Juber et al [5]. The backhoe loader mechanism must work reliably under unpredictable working conditions. Thus it is very much necessary for the designers to provide not only an equipment of maximum reliability but also of minimum weight and cost, keeping design safe under all loading conditions.They describes its basic structure, stress characteristics and the engineering finite element modelling for analysing, testing and validation of backhoe loader parts under high stress zones

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R M Dhawale1 et al [2] Excavators are intended for excavating rocks and soils. It consists of four link members: the bucket, the stick, the boom and the revolving super structure (upper carriage). The excavator mechanism must work reliably under unpredictable working conditions. Thus it is very much necessary for the designers to provide not only a equipment of maximum reliability but also of minimum weight and cost, keeping design safe under all loading conditions. The two important factors considered during designing an excavator arm are productivity and fuel consumption. Also the bucket volume is increased to compensate for the loss in production due to the reduction in digging force.

Asia et al [9]. They have described a new technique, known as Howard, for extracting data structures from binaries dynamically without access to source code or symbol tables by observing how program access memory during execution. We have shown that the extracted data structures can be used for analysing and reverse engineering of binaries that previously could not be analysed, and for protecting legacy binaries against memory corruption attacks.

Remark on Paper

Review of literature shows that many authors have reported the design to find best configuration of the tooth in terms of the geometry and they also study on modification of tooth and strength to withstand sudden change in stress while in operating. The frequency of failure of the tooth needs to be brought down. Analysis is to done to check the effect of variable design parameter with some boundary condition. This made for determining the different parameters like stresses, forces, capacity etc. as it is important to reduce failure of tooth and which is also helpful to improve the reliability**.**

III. SCOPE

This work consists to develop a computational process to predict the dynamic strength of shovel teeth. The results of Finite Element Analysis of shovel teeth will be compared with the results arrived through experiments. To measure the strength experimentally we may use impact test mchine. By knowing the dynamic strength of the shovel teeth; we will check its reliability for unpredictable working conditions.

Objective

The purpose of the exercise shall be to reduce the incidence of failure of the tooth during its specified service life.

-To select best material on properties based. -Modeling and meshing of the component.

-To analysis of shovel tooth by using standard parameters. -To determine maximum stress induced in shovel tooth.

- To find out optimum design parameters of shovel tooth for maximum stress condition.

-To do experimentation with available experimental setup and obtain result.

-To evaluate the result and compare betweenFEM software analysis and experimental results.

IV. MATERIAL SELECTION

Cast Iron

Cast iron is made when pig iron is re-melted in small cupola furnaces (similar to the blast furnace in design and operation) and poured into molds to make castings. Cast Iron is generally defined as an alloy of Iron with greater than 2% Carbon, and usually with more than 0.1% Silicon.

Two material used are classified are as follows.

1) Grey cast iron
2) Ductile cast iron

Sr.No.	Material Name	Specification No.	Grade
1	Grey		
2	Ductile Cast Iron	ASTM A536	60-40-18(d)
3	Ductile Cast Iron	SAE J434	D 5506(f)
4	Ductile Cast Iron	ASTM A536	120-90-02(d)

Application

-Shock Resistance parts & Low Temprature

-Highly Stressed parts Requiring Very Good Wear Resistance & Good Toughness.

-Highest Strenth& Wear Resistance.

Characteristics of Gray Cast Irons

Gray Cast Irons contain silicon, in addition to carbon, as a primary alloy. Amounts of manganese are also added to yield the desired microstructure. Generally the graphite exists in the form of flakes, which are surrounded by an a-ferrite or Pearlite matrix. Most Gray Irons are hypoeutectic, meaning they have carbon equivalence (C.E.) of less than 4.3.

Gray cast irons are comparatively weak and brittle in tension due to its microstructure; the graphite flakes have tips which serve as points of stress concentration. Strength and ductility are much higher under compression loads.

Properties of Gray Cast Irons

Graphite morphology and matrix characteristics affect the physical and mechanical properties of gray cast iron. Large graphite flakes produce good dampening capacity, dimensional stability, resistance to thermal shock and ease of machining. While on the other hand, small flakes result in higher tensile strength, high modulus of elasticity, and resistance to crazing and smooth machined surfaces.

V. FEM

FEM software package is used for stress analysis of tooth with some boundary condition. The loads and the resting, location etc. for experimentation should be derived from the analytical methodology. The FEM method is used to analyse the stress state of an elastic body with complicated geometry, such as gear. Also the contact and bending stresses should be calculated by using ANSYS/NASTRAN. In this thesis the analysis of characteristics of in volume spur gears in gearbox is intended for the study by using the FEM.

HyperMesh Interface

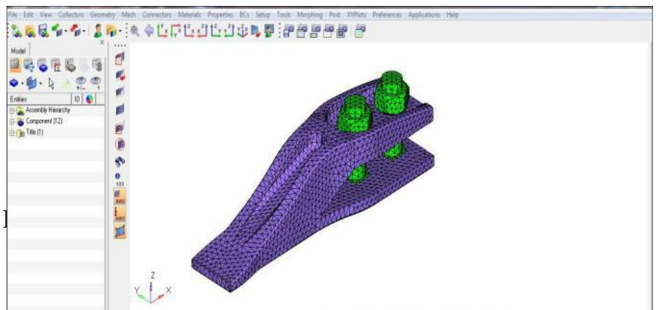


Fig.1: Exacavator bucket tooth interface

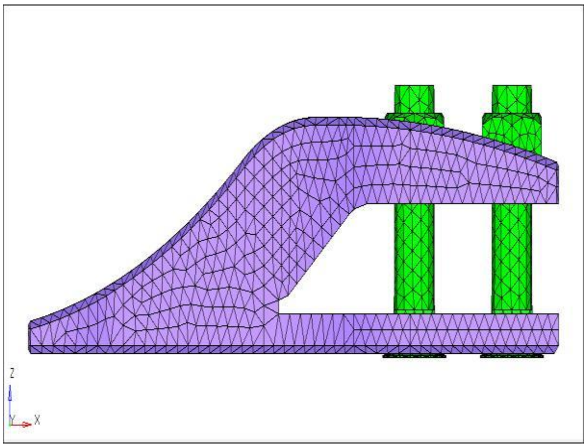
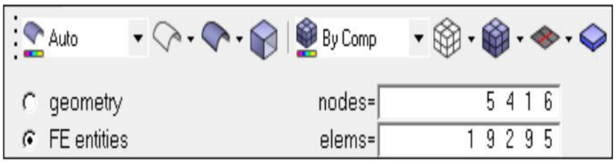


Fig.2: Side view of tooth

No. of Elements and nodes



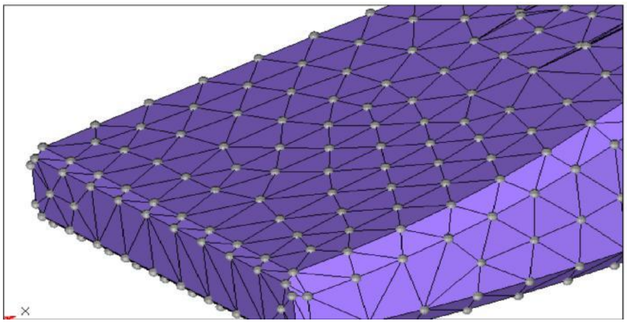
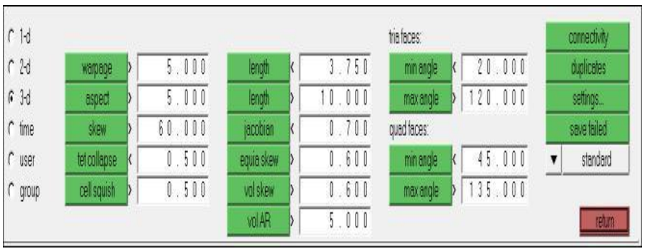


Fig.3: Types of nodes- Single order

Quality Check



Meshing Window

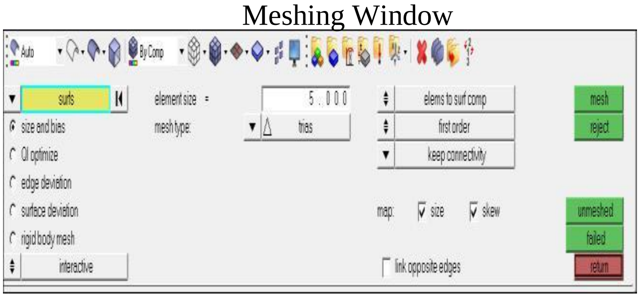


Fig.4: Quality checking and meshing parameters

Analysis of Tooth

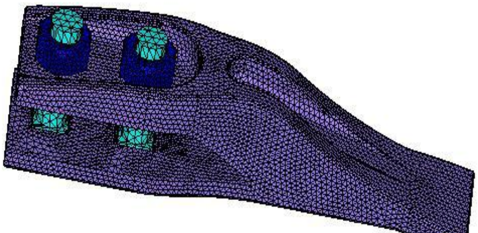
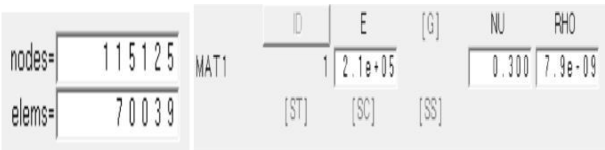


Fig.5: FE Modeling



0.5 ton of load is applied on tooth Lower surface is fixed in all direction Tooth is aligned at 45 degree from horizontal.

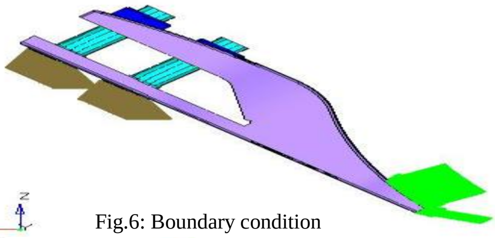


Fig.6: Boundary condition

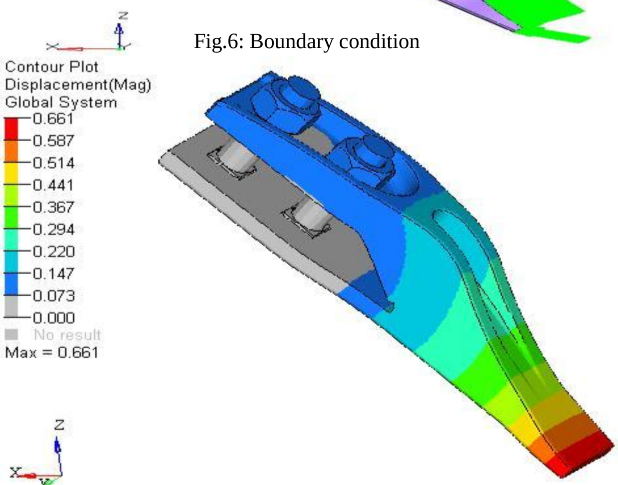


Fig.7: Displacement contour

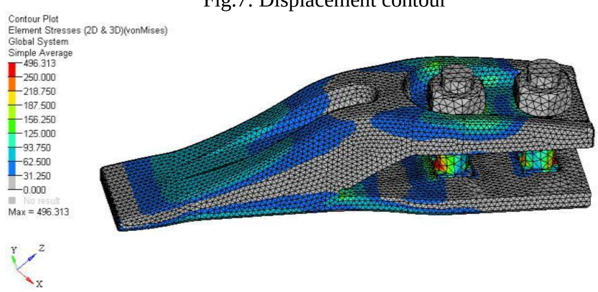


Fig.8: Stress contour

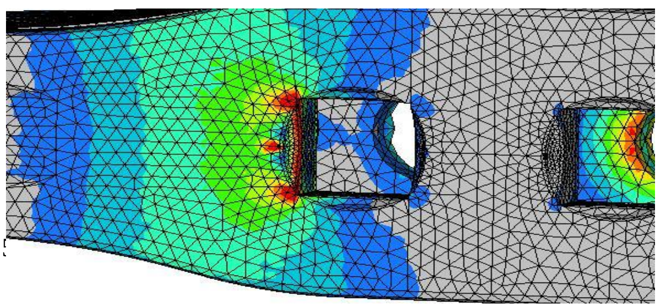


Fig.9: Maximum Stress contour

VI. CONCLUSION.

Using solving the problem by using appropriate FEA Solver for dynamic loading. Check quality parameter also stress analysis with boundary condition. Result found satisfied.

REFRENCES

[1]Bhaveshkumar P. Patel ―A Review On Kinematics Of Hydraulic Excavator's Backhoe Attachment‖,Issn : 0975-5462 Vol. 3 No. 3 March 2011.

[2] R M Dhawale1and S R Wagh ―Finite Element Analysis Of Components Of Excavator Arm―A ReviewIssn 2278 – 0149, Vol. 3, No. 2, April 2014.

[3]ShivaliSingla, VineetShibeAnd J.S. Grewal ―Performance Evaluation Of Hard Faced Excavator Bucket Teeth Against Abrasive Wear Using Mmaw Process‖ Vol 02, Issue 02; August-December 2011 Issn: 2249 – 6564.

[4]Bhaveshkumar, P Patel, J M Prajapati ―Static Analysis of Mini Hydraulic Backshoe Excavator Attachment Using Finite Element Analysis Approach‖ International Journal for Mechanical Engineering and Robotics Research, Vo1, Oct (2012).

[5]JuberHussainQureshi, Manish Sagar ―The Finite Element Analysis of Boom of Backhoe Loader‖ Vol.2,

[8]AtulSambhaji Jadhav, 2prof. A.P. Shrotri, 3swapnil Kulkarni ―Design Optimization for Front Loader Tooth of Earthmoving Equipment‖, E-Issn2249–8974 Oct.-Dec,2014/60-62.

[9] Asia Slowinska,TraianStancescu ,Herbert Bos, ―Howard: a Dynamic Excavator for Reverse engineering data structure.‖VrijeUniversityAmsterdam(2011).