# Design & Experimentation of Shovel Loader Tooth by Using Analytical Method

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***Abstract-*** **The excavator, loader etc. are commonly used for material handling at mining and construction industries. The shovel loader tooth of the excavator have to bear heavy dynamic loads of materials like soil, rock etc. The loader tooth are subjected to abrasive nature of soil particles so, the tooth got damaged due to abrasive wear and impact load.**

**The objective of work to improve the service life of the excavator bucket teeth is order to decrease ideal time required to reinstate the teeth periodically during excavation. Generally alloy steel is used to make an excavator bucket tooth and hard facing some wear resistant material can be applied on the material of bucket teeth. This paper deals with review of excavator bucket tooth analysis to find out its actual failure.**

***Index Terms-*** **Excavator tooth, Tool, Impact test, Abrasive wear, digging force.**

## I. INTRODUCTION

Rapidly growing rate of earth moving equipment of industries is assured throughout the high performance construction machineries with complex mechanism and automation of construction activity. The primary function of loader is to excavate below the natural surface of the ground on which the machine rests and load into truck. Hydraulic system is used for operation of the machine while digging or moving the material. A combination of extension and retractions of the hydraulic cylinders. Generates the required motion of the component for digging. The hydraulic cylinder simultaneously provides the gigging forces to be generate the bucket tip.

Excavator buckets are made of solid steel and generally present tooth protruding from the cutting edge, to disrupt hard material and avoid wear-and-tear of the bucket. The excavator bucket tooth have to bear heavy loads of materials like wet soil and rock and also subjected to abrasion wear due to the abrasive nature of soil particles when tooth acting to break up material 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 tooth, so that its life will improve against abrasive wear.

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.

## II. PROBLEM IDENTIFICATION

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 working conditions; all of this force need to be considered.

## III. OBJECTIVE

- To determine maximum stress induced in shovel tooth.
- To analysis of shovel tooth by using various method.

- To select best material on property based.
- To do experimentation with available experimental setup and obtain result

## IV. RELAVANCE

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

## V. LITERATURE REVIEW

To understand the background of the dissertation work, following research paper dealing with this topic have been studied.

Asia et al [1]. 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 analyzing and reverse engineering of binaries that previously could not be analyzed, and for protecting legacy binaries against memory corruption attack.

Juber et al [4]. They describes its basic structure, stress characteristics and the engineering finite element modeling for analyzing, testing and validation of backhoe loader parts under high stress zones.

Sachindiran et al [2].The production rate of the excavators is a good indicator of the performance of a blast. Such rate can be easily determined, with acceptable accuracy, either manually or from dispatch data. A model has been developed to estimate the mucking production rate in bank cubic meters per hour, as the product of an ideal, maximum rate, times an efficiency that accounts for the rock strength and the energetic powder factor.

Bhaveshkumar et al [5]. 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 part without welding. It is clearly depict that the welding strengthen the part. Based on result also we can conclude that the maximum stress produced in the part are very less compare to limiting (safe) stress of parts material. Therefore there is scope to perform the structural optimization of the excavator attachment for weight reduction.

R M Dhavale et al: Excavator is intended for Excavating rocks and soil. It consists of four link member: the bucket, the stick, the boom and the revolving super structure (Upper carriage). The excavator mechanism must work reliably under unpredictable working condition. Thus it is very much necessary for the designer 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 are considered during designing an excavator arm are productivity and fuel consumption. Also the bucket volume increased to compensate for the loss in production due to the reduction in digging force.

## VII. REMARK

Review of literature show that many author have reported the designed to find best configuration of the tooth in term of geometry and they also study in modification of tooth and strength to withstand sudden change in stress while in other 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 parameter like stress, Forces, Capacity etc. As it is important to reduce failure of tooth and which is also helpful to improve the reliability.

## VIII.MATERIAL SELECTION

Grey cast iron (a.k.a. gray iron) is a type of iron found in castings known for its grey color and appearance caused by graphite fractures in the material. Specifically, what makes grey iron “grey iron,” is the graphite flake structure that is created during the cooling process from the carbon that is in the component.

The constituent in gray cast iron :

| ELEMENTS | C | Si | Mn | S | Ph |
|---|---|---|---|---|---|
| COMPOSITION (%) | 2.5-4.2 | 1.0-3.0 | 0.15-1.0 | 0.02-0.25 | 0.02-1.0 |

PROPERTIES:

- High tensile strength.
- High shock resistance
- High compressive strength

APPLIC ATION:

- Automobile panel
- Excavator part
- Casting parts

## IX. ANALYTICAL CALCULATION

### A. MATERIAL PROPERTIES

Tooth: AISI 1040

Modulus of elasticity = 124 GPa

Poisson's ratio = 0.271

Ultimate tensile strength = 310 Mpa

Yield tensile strength = 210 Mpa

### B. BENDING STRESS CALCULATION

h = 18mm

y = 26mm

M= Force x eccentricity

= 5232 x 150

= $784.8 \times 10^3$ Nmm

Ixx 1 = $bd^3/12 + (Ah^2)$

= $2\{16 \times 14^{3}/12 + (16 \times 14 \times 18)\}$

= 2{43904 /12 + (72576)}

= 2(76234.667)

= 152469.33 $mm^2$

= $152.469 \times 10^3\ mm^2$

Ixx 2 = $bd^3/12 + (Ah^2)$

= $2\{16 \times 16^3/12 + (16 \times 16 \times 18)\}$

= 2{65536 /12 + (82944)}

= 2{5461.33 + (82944)}

= 2 (88405.33)

= 176810.66 $mm^2$

= $176.810 \times 10^3\ mm^2$

Ixx = Ixx 1 + Ixx 2

= $152.469 \times 10^3 + 176.810 \times 10^3$

= 329306

= $329.306 \times 10^3\ mm^2$

$M / I = \sigma_b / y$

$784.8 \times 10^3 / 329.306 \times 10^3 = \sigma_{b} /26$

$\sigma_b = 61.963$ $N/mm^2$

*Bending stress = 61.963 MPa*

### C. SHEAR STRESS CALCULATION

Force = 5232 N

Area = 1311.83 $mm^2$

$\sigma_s = 5232 / 1311.83$

= 3.988 MPa

*Shear Stress = 3.988 Mpa*

## X. CONCLUSION

In this paper we obtain the result by analytical method. We concluded that the maximum stress acting on tooth, then we compare the analytical value with experimental value and selected a suitable material for tooth.

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