ABSTRACT:

Background/Objectives: The objective of our research work is to increase the life and performance of the excavator bucket teeth.

Methods/Statistical Analysis: One of the important machinery for building and excavation activity is the excavator. Used widely for digging the soil for making pits and removing the soil using the excavator bucket teeth. The tooth is usually made of solid steel which undergoes corrosion and breakage very easily. To overcome this problem, we analyzed in our work the properties of the conventional material and the material we recommend as a substitute i.e. Inconel 625. Inconel is an alloy of nickel, which has superior strength and corrosion resistant properties towards the wet and alkaline soil. Thus improving wear and strength of the teeth. This can be proved to be a changing advantage for the excavators.

Keywords: Excavator, Bucket, teeth, Plunger, digging angle, Inconel 625.
1. INTRODUCTION:
In the era of two thousand due to the changes of science and technology manpower has reduced drastically and working time and execution of project also tremendously reduced due to heavy powered vehicles such as excavator and new materials.
Excavators reduced working time by handling heavy works like earth moves, digging of soil rocks for the development of infrastructure. so that it require more toughness and wear resistance and abrasion resistance.

2. EXCAVATOR PARTS
The Excavators are widely used mechanical machinery, in order to achieve the best performance while digging of soil the tooth must have superior properties the model figure of excavator are shown in Figure 1. These are most commonly used in the building and excavation of the soil. They generally work on internal expanding hydraulic cylinder mechanism by which the movements of rams take place and the forces are applied to the digging. Some of the important components of the excavators are:

- bucket
- boom
- stabilizer legs
- Loader
- Backhoe
- Stick
- Cab
- tractor

Figure – 1 Excavaor
Types of Excavator

There are several types of excavators used in various engineering applications. Although they may be different in shape, size, capacity or functionality, but they serve the same purposes.

1. Crawler Excavator

Crawler excavator runs on two endless tracks (chain wheel system). These types of excavators are used in hilly areas where risks of sliding of machinery are on the verge. Crawler type excavator has low ground pressure because of spreading of load on a large area. Therefore, it is also used where soil support is weak.

2. Wheel Excavator

Wheel excavator runs on wheels and is used for excavation and loading of dump trucks and most of the time it is only used for plain ground operations. Because of the wheel, it is not suitable for hilly areas due to low grip value to the ground. Excavators are vehicles that are used on construction sites to move material.

3. PROBLEM IDENTIFIED:

Occasionally tooth’s used to get break depending on working environment are shown in Figure 2. Purpose of finding failure of tooth’s got complaints from the owner of the truck frequently. So that there is a requirement for highly toughened tool through that identified problem through the following questioners like what, when, where, why.

What - for this question found the parts frequently fail ie digging tooth.

Where - for this question failure used to occur at what environment? Failure used to occur strong soils like cucumber drum, hard rock’s due to its inflexibility. Here wear are high and at hard rock’s impact loads are high,

When - the excavators works continuously and summer, due to more heat transition on metal failure occurs.

Why – for this question simply it is due to crack propagation from the abrasion of tool on hard rocks. to reduce the wear of the bucket unit.

How this will be rectified are by selecting the correct materials for the kind of force and load and abrasion resistances. The result we found are INCONEL based on the literatures.
Then there is a possibility of the failures at the following places:

- the breaking of the pin in tooth adapter assembly.
- bending of tooth point.
- Breakage of tooth adapter part.
- Corrosive wear of teeth.
- Breakage of teeth tip

4. METHODOLOGY USED

To avoid the excavator tooth failure the following methodologies followed as shown in Figure – 3.
Based on the methodology were conducted all the testes and the tested samples are shown in Figure 4a, 4b and 5a, 5b as per the ASTM standard.

Figure 4a. TENSILE SPECIMEN FOR AISI-1040

Figure 4b TENSILE SPECIMEN FOR INCONEL 625

Figure 5a. Impact specimen for AISI 1040
RESULTS AND DISCUSSION:

5. MECHANICAL TESTING:

The comparing materials of AISI-1040 and Inconel-625 were found that the results on AISI 1040 yield strengths is lesser than the used materials on excavator and the inconel-625 shows better yield and toughness when compare to using materials in excavator in Figure 6 and 7. The same is replica on analytical results of ANSYS results of the same material as per the specified parameters of FEM.

Figure 6-AISI 1040 – FATIGUE GRAPH

Figure-7, INCONEL 625 – FATIGUE GRAPH

6. ANALYTICAL REPORTS

6.1 AISI 1040 REPORTS
Equivalent Stress

Equivalent Elastic Strain for AISI 1040

Von-Mises Stress For AISI 1040
6.2 INCONEL ANALYTICAL REPORTS

1. Total Deformation For Inconel 625

2. Equivalent Stress

3. Total Deformation For Inconel 625
Shear Stress

Shear Elastic Strain

7. COMPARISION OF OBSERVATIONS

<table>
<thead>
<tr>
<th>TESTS</th>
<th>INCONEL 625</th>
<th>AISI 1040</th>
</tr>
</thead>
<tbody>
<tr>
<td>TENSILE STRESS (MPa)</td>
<td>886</td>
<td>712</td>
</tr>
<tr>
<td>YIELD STRESS (MPa)</td>
<td>512</td>
<td>436</td>
</tr>
<tr>
<td>% ELONGATION</td>
<td>42</td>
<td>22</td>
</tr>
<tr>
<td>HARDNESS (HBW)</td>
<td>189</td>
<td>183</td>
</tr>
<tr>
<td>IMPACT (JOULES)</td>
<td>59.33</td>
<td>36.66</td>
</tr>
</tbody>
</table>

8. OBSERVATIONS

- It is observed that the region near the bush and teeth are having a high value of stress and hence they are more prone to failure.

- The material will be separated if applied stress exceeds ultimate tensile stress.
  
  Also, the observations are

- Maximum stresses are generating at the fixed position of the tooth.

- Maximum deformation will occur at the tip of tooth to the whole body.

In all the tests performed it is clearly that the material Inconel was proved to be superior to AISI 1040.
• Total tensile strength for AISI 1040 and Inconel 712MPa & 886MPa respectively
• The impact strength of Inconel is also 59 over 36 of AISI 1040.
• Hence it is clear that material INCONEL is stronger than material AISI 1045.

9. CONCLUSION
All the above mechanical tests show that the materials of presently using is not suitable for the excavator, because it is not withstanding the forces occurred while in work. This is observed through results of experiments in tensile and impact and Analytical result of the same.
This stress can be avoided when redesign excavators bucket tooth increasing the mechanical properties and redesign of the excavator’s bucket tooth using inconek-625.
Inconel is superior to AISI 1040, by replacing the material
• the life of teeth is improved
• the weight is reduced
• better corrosion resistance.

10. REFERENCE