Identification and Measuring of Wear in Bucket Teeth Excavator by ASTM G65 Standred

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Abstract- *Now a day constantly and rapidly enhancement rate of industry of earth moving machines is assured through the high performance construction machines with automation and complex mechanisms. An excavator bucket tooth is an attachment for heavy equipment which is designed to be used in site excavation. Abrasive wear, fatigue wear or combination of both wear takes place on bucket tooth due to its working environment and loading conditions. ASTM G65 standard is widely used by industry to assist the selection of material for the describe service in abrasive wear environment. This paper is related to identify the type of wear in bucket tooth and propose wear measuring machine to calculate wear coefficient by ASTM standard.*

Keywords- Excavator bucket tooth, Abrasive wear, ASTM G65

I. INTRODUCTION

Wear is a major problem in the excavation, earth moving, mining and minerals processing industries and occurs in wide variety of items, such as bulldozer blades, excavator teeth, ball mills, rod mills, slurry pumps and cyclones. Wear is generally described as abrasive, adhesive, corrosive or erosive. Among all these types, the detail study of abrasive wear is important due to its destructive nature. Abrasive wear is defined as the removal of material from surface in relative motion, caused by sliding of hard surface over a soft surface. The bucket teeth of excavator are generally used in construction industries for excavation purpose undergoes cyclic loading and tooth will wear according to time and working environment. Wear of bucket teeth are more often due to abrasive wear. For measuring wear coefficient of a particular material, there is need to design a development of wear measuring machine. ASTM (American Society of Testing Materials) G65 standard is widely used for testing a material (specimen) on dry sand rubber wheel test (DSRW) apparatus. Paper describes the identification of types of wear in bucket teeth excavator and proposed design of dry sand rubber wheel test by ASTM G65 standard. [1]

A. WEAR AND WEAR MECHANISMS

Wear is defined as damage to a solid surface, generally involving progressive loss of material, due to relative motion between that surface and a contacting substance or surface. Wear processes can be classified into different types according to the type of tribological load and the materials involved, e.g., sliding wear, fretting wear, abrasive wear, and material cavitation. Wear is caused by a number of mechanisms, the following four being especially important:

- Surface fatigue
- Abrasion
- Adhesion
- Tribochemical reaction

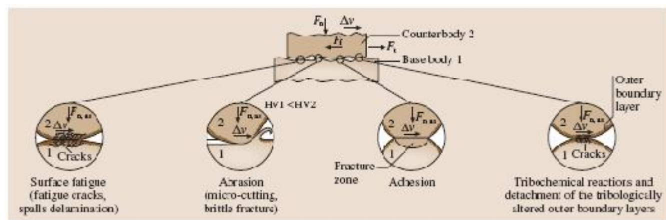

Fig.1. Basic wear mechanisms viewed microscopically (Fn normal force on apparent contact surface, Ff friction force between base body and counter body, Fn, as normal force on asperity contact, Δv relative velocity)[2]

Apart from this type of wear mechanisms, it can also be classified by interpreting the results of wear following table shows the wear type and wear phenomenon.

Table1. Typical wear phenomenon caused by the main wear mechanism [2]

Wear Mechanism	Wear Phenomenon
Adhesion	Scuffing or galling areas, holes, plastic shearing, material transfer
Abrasion	Scratches, grooves, ripples
Surface fatigue	Cracks, pitting
Tribochemical action	Reaction products (layers, particles)

B. EXCAVATOR BUCKET TEETH

Excavator buckets are made up of solid steel and generally present teeth protruding from the cutting edge, to disrupt hard materials and avoid wear and tear of the bucket. Excavator buckets are mainly classified in two different parts.

- Ditching bucket
- Trenching bucket

Ditching bucket is a wider bucket with no teeth in front of bucket. It is 5 to 6 feet (1.5 to 1.8m) long. The main purpose of ditching bucket is for excavating larger excavations and grading stone.

Trenching bucket is smaller in length as compared to ditching bucket. It is 6 to 24 inch (150 to 610 mm) wide with protruding teeth used for excavating sand and other constructional used. [6]

Fig.2. Failure of bucket teeth

C. ACTUAL WEAR IN BUCKET TEETH OF EXCAVATOR

As per survey of different types of wear that can be seen on teeth of bucket of excavator, the abrasive and fatigue wear has become a prominent wear. Generally the excavator teeth have combination of both the wear i.e. abrasive wear and fatigue wear as per the working condition and environment in which excavator working .Following figures shows new bucket teeth which are available in market for sailing purpose and abrasive wear of bucket teeth is due to working of excavator for a particular application.

Fig.3. New bucket teeth

Fig.4. Abrasive wear on surface of bucket tooth.

For testing various types of material that will form abrasive wear for a particular application there is need to design and develop abrasive wear testing machine. This paper describes a proposed machine and testing procedure as per ASME standard.

II. DESCRIPTION OF TEST AND EQUIPMENT

Before starting the test there is need to know in detail about abrasive wear and condition to use this type of test.

A. ABRSIVE WEAR

Laboratory abrasive wear tests are classified by geometrical arrangement and the stress level of the components of the system. If the load is sufficient to fracture the abrasive particles, the wear is called high-stress abrasive wear; if the particles do not fracture significantly, it is called low-stress abrasive wear. If the abrasive particle is in contact with only one other object, such as another wear surface or other abrasive particles, it is called three-body wear. Describe machine is used for three body abrasive wear application. [2]

B. DRY SAND RUBBER WHEEL TEST

The dry-sand, rubber-wheel (DSRW) abrasion test apparatus simulates low-stress, three-body abrasive wear. In bucket tooth of excavator which is mostly used in construction industry undergoes a three-body abrasive wear. It suffers slow wear from the sliding and rolling action of abrasive fragments of rock, sand and cement. Because this type of wear is slow, field trials alone would be too slow quick and gives a reasonable correlation with the field tests. Even before the test became an ASTM standard G65 in 1980, it had been used by a number of laboratories for many years. The equipment has two test parameters, the sliding distance i.e. the number of wheel revolutions and the specimen load. [4] The ASTM recognizes procedures using variations of these two test parameters. For design this machine was taken into account the characteristics of this test in order to determine the abrasive wear of different materials. The schematic representation of machine is given in following figure.

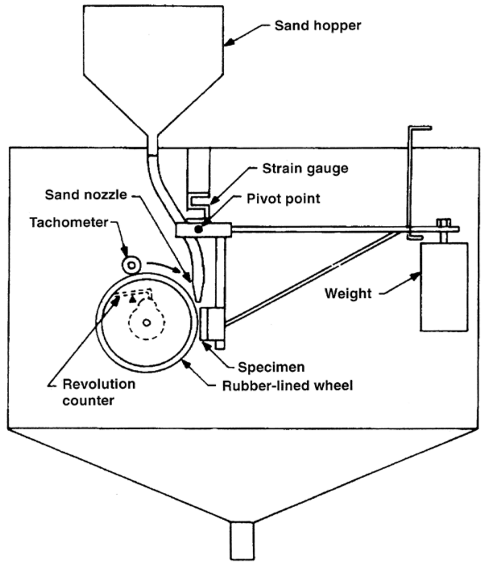

Fig.5. Schematic representation of the DSRW wear tester.[4]

The main parts of the machine need to be designed as per ASTM standard given below.

1) Mechanical system

It’s taking upon of hold the specimens, support the dead loads that will be applied and transmit movement to the disk, this is achieve by means of the following elements:

- Rubber lined wheel

According to ASTM G65, rubber wheel consists of a steel disc with a defined hardness rubber ring which is molded on the perimeter of a steel disc. The overall diameter is 228.6 mm and the width and thickness of the rubber should be 12.7 mm. The rubber wheel has a constant speed of 200 RPM ± 10 RPM.

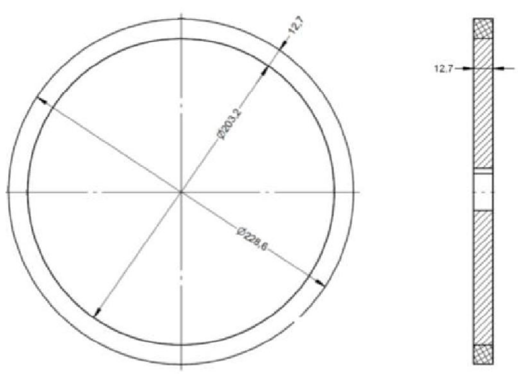

Fig.6. Rubber lined wheel

- Geometry and dimension of sample.

The samples should have rectangular shape measuring 25 mm x 75 mm and the thickness should be in the range 3.2 mm and 12.7 mm. The size can be varied according to the needs of those who perform the test, with the restriction that the length and the width are sufficient to demonstrate the full length of the wear track. The test surface must be flat within 0.125 mm maximum, as well as to a surface roughness below 0.8 micrometers. [5]

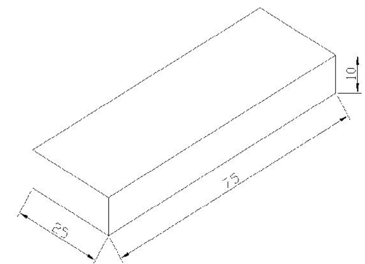

Fig.7. dimension of sample

- Abrasive hopper

The hopper is making of ASTM A570 Steel and to provide following parameter.

Maximal sand flow rate: 400 g/min.
Maximal time of the test: 30 min.
Sand density: 1.6 L/kg.
Then the maximal capacity of sand request
(0.4 kg/min)(30 min)(1.6 L/kg) = 19.2 L

2) Electric system

This system is responsible for providing movement to the machine through a system of gear motor, pulleys, bearing and shaft that give movement and torque of the metal wheel.[5]

III. WEAR MEASUREMENT

Wear measurement is carried out to determine the amount of materials removed after a wear test. The material worn away can be expressed either as weight (mass) loss, volume loss, or linear dimension change depending on the purpose of the test, the type of wear, the geometry and size of the test specimens, and sometimes on the availability of a measurement facility. In our case we are using a precision balance to measure the weight (mass) loss and microscope to measure the wear depth or cross-sectional area of a wear track so as to determine the wear volume loss or linear dimensional change. [2]

Table2. Wear measurements methods and typical units of wear quantification [2]

	Measurement Methods	Units of wear	Units of wear rate
Mass Loss	Direct measurement by precision balance Calculated from volume loss of known density material.	µg g	µg/m, g/m, µg/N, g/N µg/(N.m), g/(N.m)
Volume Loss	Calculated from depth, width, wear profile and/or other dimensions data of wear track. Calculated from mass loss for known density material.	mm^3	mm^3/m mm^3/N $mm^3/(N.m)$
Linear Dimension	Surface microscopy measurement.	µm mm	µm/year mm/year

IV. CONCLISION

The prominent wear in bucket tooth excavator is abrasive wear and measuring abrasive wear, we proposed machine by ASTM G65 standard. The design and construction of the dry sand - rubber wheel apparatus complies with the established work parameters in the ASTM G 65 standard is easy rather than to import it. The propose machine is very important in Tribology Laboratory of mechanical engineering college and it can be used for teaching and research purposes related with knowledge consolidating in abrasive wear that can acquire students on various materials.

ACKNOWLEDGMENT

I gratefully acknowledge my project guide and HOD of department Dr. V. V. Shinde for his guidance and support. We thank him for the encouragement and support he has given me for the project. We thank our Principal, Dr. M.S.Gaikwad, and all my professors for imparting their knowledge and their support.

Last but not the least we are thankful to all those people who helped in the project activities.

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