FABRICATION OF ABRASIVE TESTING MACHINE FOR WEAR TEST

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Abstract: *Abrasive failure is a phenomenon observed in objects having relative motion, either resulting in reduced functionality or failure of component. Industries using rubber as raw material face the abrasive wear failure issues in their products. With the advancement of powerful and high capacity transportation vehicles, tire industries are working on developing materials that can withstand severe operating conditions. Field trial of parts consume more time and cost, hence, a modification is done in ASTM G65 standard testing machine to suit their usage as wear tester for rubber parts. Design and fabrication of modified rubber wheel apparatus is done to check abrasive wear in the material. Lever arm principle is used to force specimen against the rotating rubber wheel. Abrasive particles are made to flow in-between the rotating rubber wheel and specimen. By comparing the mass of a material before and after the test, abrasive wear in materials is determined. This method is helpful in selecting the materials for working in abrasive environment.*

Keywords: *Abrasive wear; Wear rate; Wear on rubber; Modified Rubber wheel apparatus; ASTM G65*

1. INTRODUCTION

1.1 Introduction

The abrasive wear in moving components results in loss of functionality of the part and the damage induces the repeated replacement of parts. Therefore, testing the mating materials before using them in functional parts helps in saving cost due to replacements. Various studies related with the tribology were performed and as a result, abrasion tester helps in selecting the materials. The ASTM G65[1] standard for abrasive wear test is widely used by industry to assist in selecting metallic materials for abrasive wear service.

With the advancement and availability of powerful and high capacity vehicles, Tire industries are working towards new material development to suit those applications. Tires for all weather conditions, off-road vehicles, hillclimbing, racing, etc.. are few areas where improvements are being made. These products need contradicting properties embedded in a single material.

To understand the characteristics and functioning of materials developed, it is essential to do field trials. Without the final product, field trials are not possible. Performing field trials simulating different environments is time consuming and tedious process, which cannot be done for all new materials developed. In few cases, the materials fail miserably during field test making waste the cost incurred and time spent in the process.

1.2 Problem Definition

Finding the suitability of material at initial stages of new material development saves cost and time. Waste of time and cost incurred after doing field trials is not an ideal method in

developing and testing of new materials. Also the currently available systems have a fixed environment capability, so that the developed materials cannot be tested for multiple requirements. Levvan Engineering and Automation private Limited is a solution provider and are developing machinery for Tire & Rubber industries. They also serve automotive, injection molding and food industry. In collaboration with Levvan Engineering and Automation, solution is provided for the above said problem.

2. LITERATURE REVIEW

2.0 Literature Review

In earlier days, the abrasive testing was done in various methods such as two-body abrasive wear testing, sliding wear testing and mar abrasion testing but in terms of precision and cost effectiveness, rolling abrasion method is highly suitable. ASTM standards were reviewed, [1] to find the suitable method to fabricate the abrasion testing machine for rubber materials.

Reniel Estrada Yanes, Luis Negrin Hernandez, Omar Zamora Morera, Nelson Cardenas Olivier, Acacio Figureueiredo Neto investigated about the Standard test method for measuring abrasion using the dry sand wheel apparatus as per ASTMG65 standard [2].

A N J Stephan and I M Hutchings reviewed suitability of dry sand/rubber wheel apparatus for metallic materials as per ASTM Standard hand books [3].

Metal abrasion testing in dry and wet conditions are available as pin-n-disc apparatus. For tests to be performed, both the pin material and disc material are to be fabricated to replicate the environment. Use of pin-on-disc apparatus for rubber material is not possible as the rubber materials have poor shear strength and its usage as pin material is not possible.

3. PROPOSED SOLUTION AND METHODOLOGY

3.1 Proposed Solution

Metallic abrasive wear measurements are carried out as per ASTM G65 standards [4]. Abrasive particles are made to move in-between the surfaces replicating the environment. By fabricating a similar setup, and by using the mixture of abrasive powder particles, any environment can be replicated. Small size specimen can be fabricated out of new materials developed and tested using the equipment for its abrasive wear behavior.

3.2 Methodology

Methodology for the proposed solution is in form of rolling abrasion tester. In this method, abrasive particles in form of powder of different sizes such as silicon carbide is used. Rotating wheel with its circumferential surface coated with

butadiene rubber is used for making the abrasives come into contact with specimen.

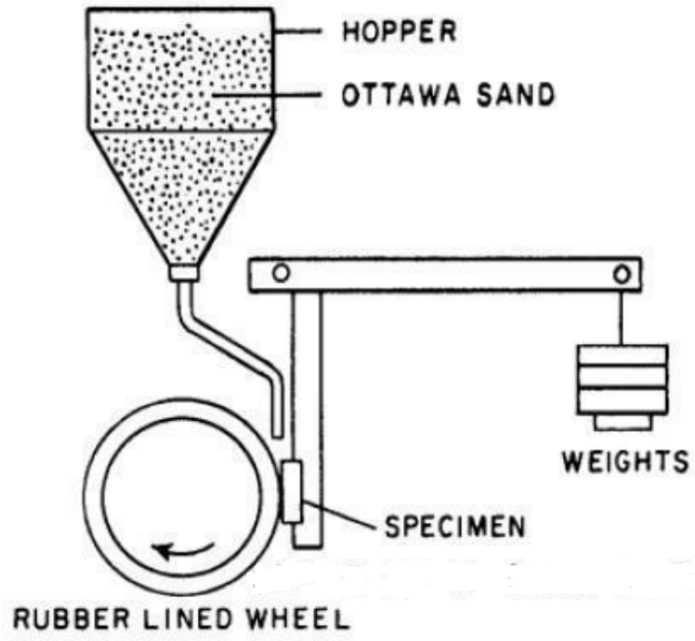


Figure 3.1 Line Diagram of Abrasion wheel tester

Specimen is fixed in specimen holder and loaded against rotating wheel using crank lever apparatus. By principle of moments, load at one end transfers moment through 'L' angle and presses the specimen against the rotating wheel. Abrasive particles are allowed to roll between the specimen and the rubber wheel. By this method, we can obtain the wear data of a material by replicating working environment [5,6].

4. CONSTRUCTION

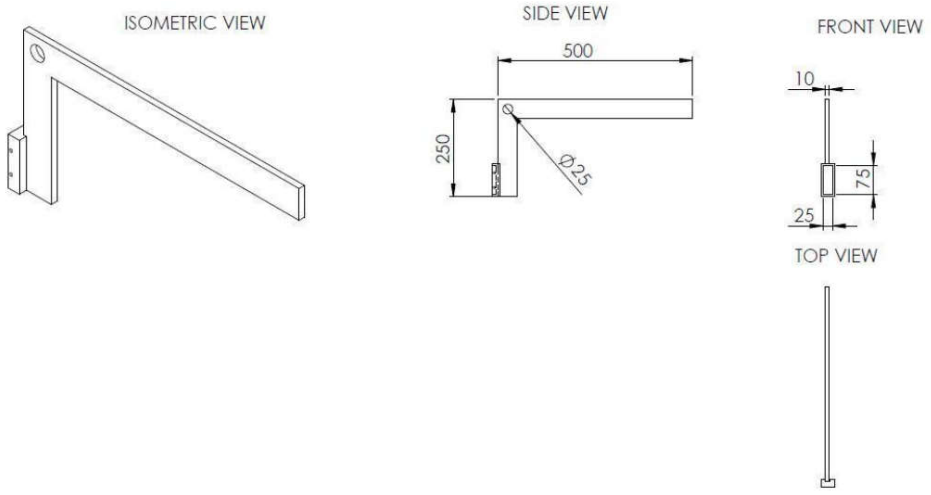
4.1 Construction

The apparatus is majorly composed of the parts namely,

1. Lever arm with specimen holder
2. Frame and hopper
3. Wheel and Motor drive system

4.1.1 Lever arm with specimen holder

L-type lever arm is used in the apparatus which is cut in the shape of L as per dimension. Holes of 20 mm were drilled, one hole is drilled for pivoting and one for weight hanger. The function of arm is to transfer the load applied to one end using lever arm principle.



All dimensions are in mm

Figure 4.1 Lever arm with Specimen holder

4.1.2 Frame and hopper

Frame is made up of mild steel. L channel is used to mount other parts such as frame and wheel etc. It is mostly fabricated by means of arc welding some parts other than the L channel is fabricated by means of gas cutting. Frame is the base part on which all moving parts like motor drive, rotating wheel, lever arm and hopper are fixed.

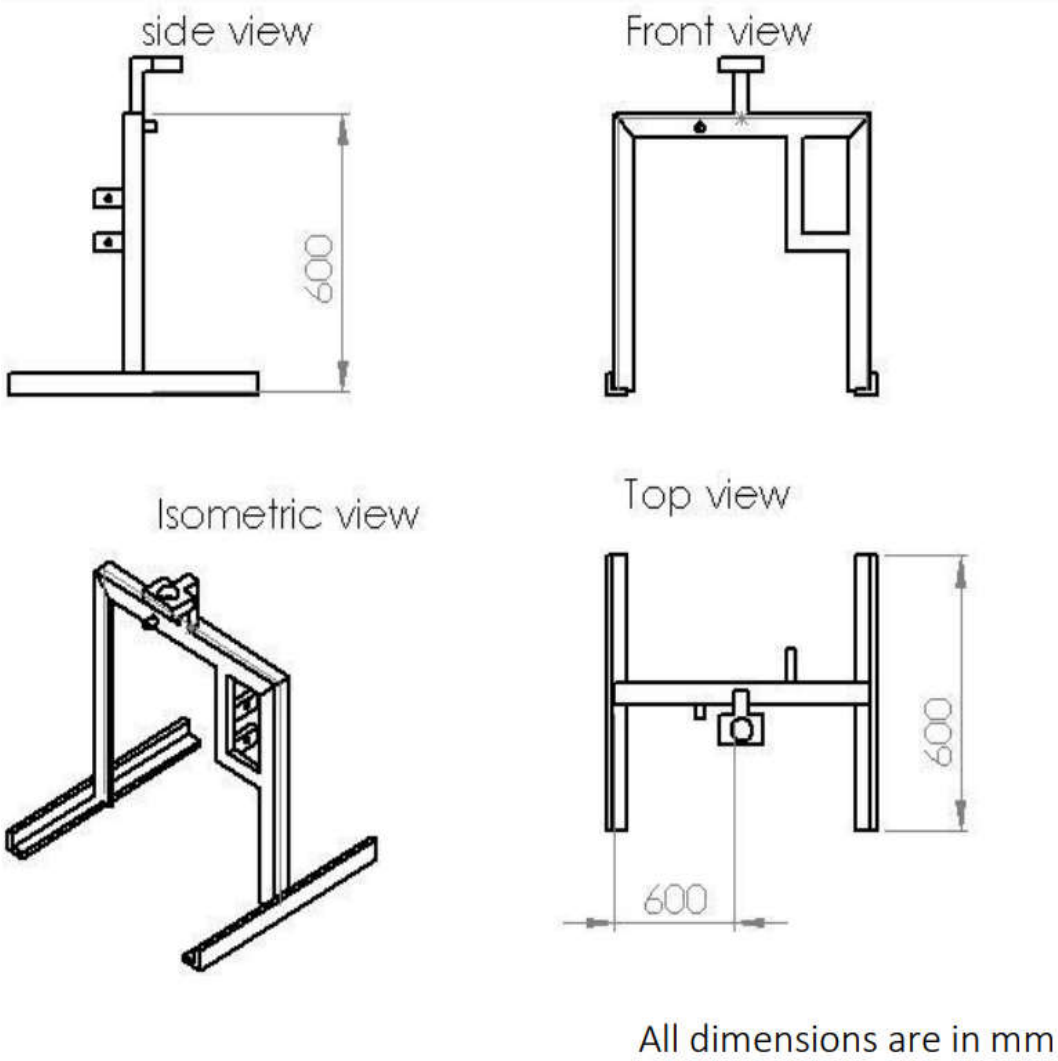


Figure 4.2 Frame and Hopper

4.1.3 Wheel and Motor drive system

Wheel is made up of cast iron where circumferential area is covered by means of the rubber (butyl rubber), which pasted over the wheel by means of adhesive paste. Then, it is connected with the shaft and pulley for the motor driving. Pulley is also made up of cast iron. Motor capacity is 0.5 HP.

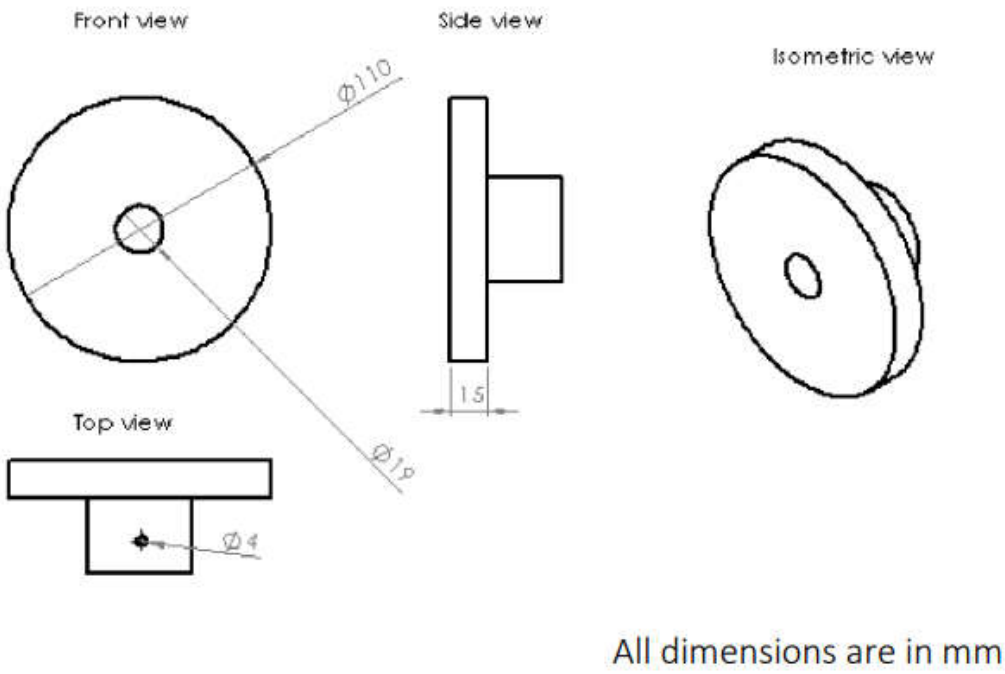


Figure 4.3 Rotating wheel

4.2 Design consideration for Lever arm

To design Length of Arm, L, we use principle of moments.

4.2.1 Moment calculation

Length of the arm from pivot point = 500mm =0.5m

Load applied =10N

Moment at pivot point = Load x perpendicular distance

Moment at pivot point = 0.5x10 =5 Nm

Load at specimen holder = Moment/ perpendicular distance

Perpendicular distance = 0.25m Load =5/0.25 =20N

Thus force multiplication takes place in the ratio of 1:2 by principle of moments.

5. WORKING PRINCIPLE

5.1 Working principle

The abrasion tester works based on the rolling abrasion method where the specimen is forced towards the rotating rubber wheel [5,6]. The abrasive particles are allowed to fall from the hopper so that abrasive particles will create abrasive wear on the specimen as shown in figure 5.1. By comparing the mass of the specimen before and after undergoing the test so that we can calculate the wear of the material.

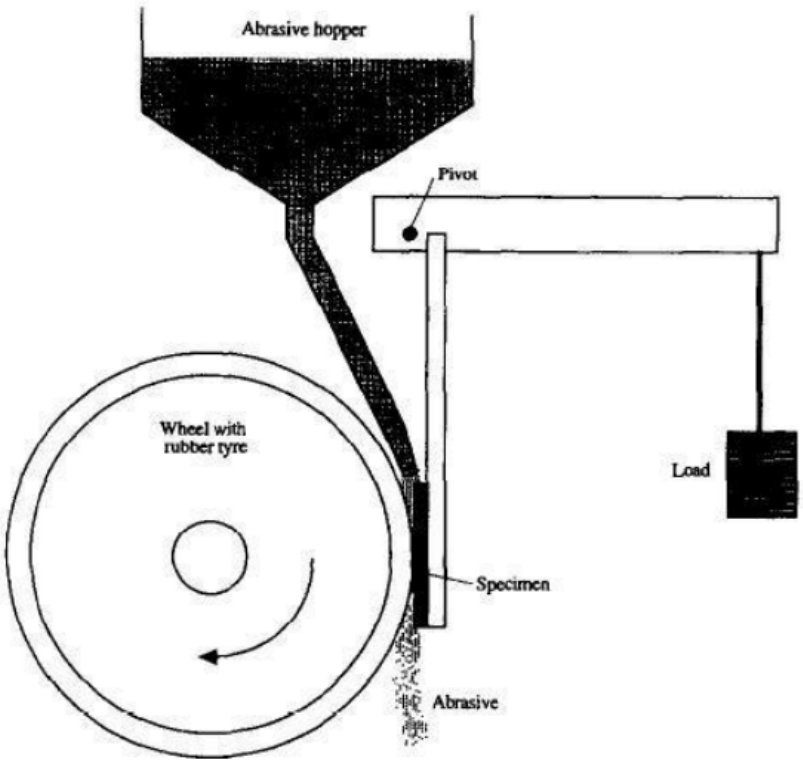


Figure 5.1 Schematic Diagram

We can also change the working condition of the apparatus by changing wheel speed, abrasive particle mixture, abrasive flow rate and load on the specimen thus we can obtain various results for the specimen in single abrasion testing equipment. The fabricated apparatus is shown in figure 5.2.

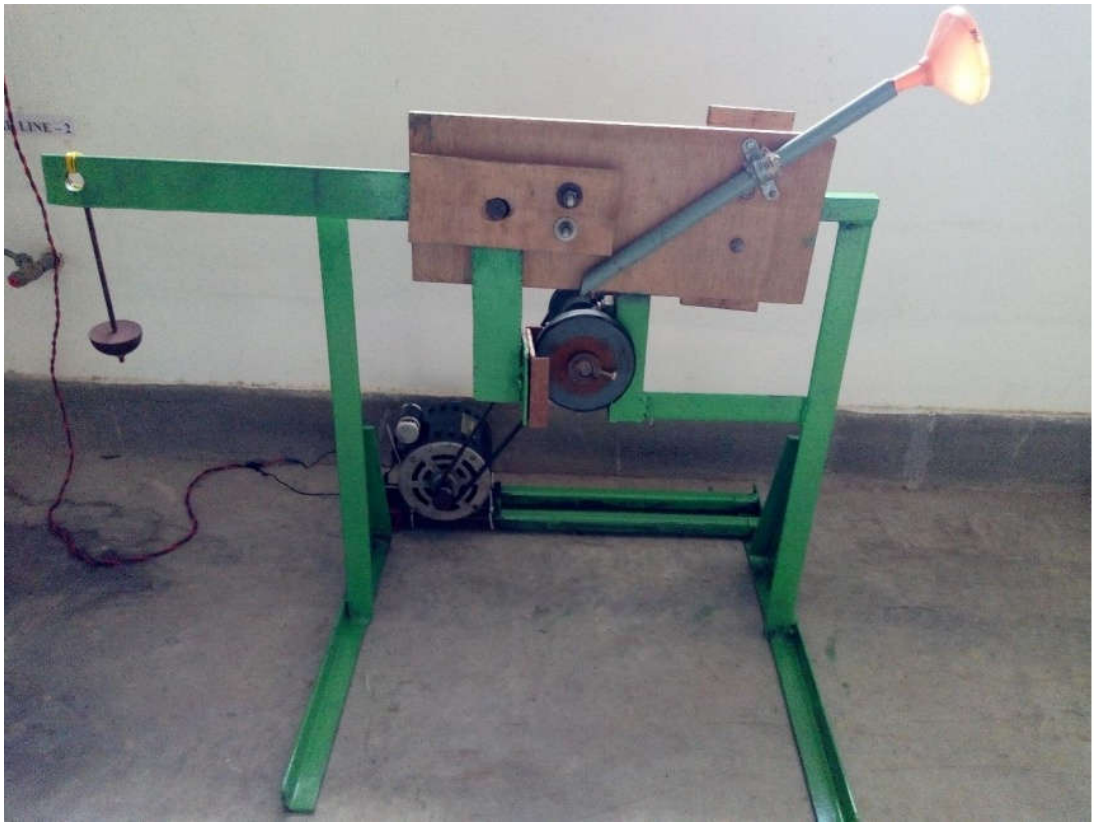


Figure 5.2 Fabricated Equipment

The major application of the abrasion tester is to find out the abrasive wear of the specimen by changing the working parameters based on real time conditions. Parameters such as

1. Load on Specimen
2. Abrasive Particle size
3. Abrasive Particle flow rate
4. Speed of wheel
5. Abradant properties, namely hardness and crushing strength
6. Abradant particle shape or angularity

6 CONCLUSION

The apparatus fabricated is helpful in understanding the wear behavior of rubber materials. It provides the opportunity to replicate real time parameters in the machine by changing the wheel speed, abrasive particles mixtures, abrasive flow rate and load acting on the specimen. It also provides features to use different type of abrasive particles like silicon carbide, Al_2O_3 and even we can use sand for

abrasion testing. The results would be useful for the selection of materials for the real time application and also it's capable of testing the new materials.

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