ISSN : 2457-0435

EAST POINT
COLLEGE OF ENGINEERING AND TECHNOLOGY

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IJSRMME

National Conference on Recent Advances in Mechanical Engineering and Materials NCRAMEM-2020

Organised by
Department of Mechanical Engineering,
East Point College of Engineering And Technology,
Avalahalli, Bengaluru, Karnataka, India

Volume 4, Issue 7, November-December-2020

INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH IN MECHANICAL AND MATERIALS ENGINEERING

Email : ijsrmme@gmail.com, editor@ijsrmme.com

EAST POINT COLLEGE OF ENGINEERING & TECHNOLOGY

Conference Proceedings

National Conference on Recent Advances in Mechanical Engineering and Materials

NCRAMEM-2020

11th - 12th January 2021

Organised by

Department of Mechanical Engineering, East Point College of Engineering And Technology, Avalahalli, Bengaluru, Karnataka, India

In Association With

International Journal of Scientific Research in Mechanical and Materials Engineering

[Peer-Reviewed International Scientific Refereed Journal]

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Published By

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ABOUT THE CONFERENCE

The objectives of the National Conference On "Recent Advances in Mechanical Engineering and Materials" is to bring the distinguished academicians, scientists, R & D professionals, industrialists and research scholars who are actively involved in research, on to a common platform for sharing their views, ideas and experience related to mechanical engineering. The conference will provide all the participants, an opportunity for developing interaction among academicians, engineers from industries and researchers. Paper presentation, invited lectures and discussions will be arranged during the conference.

TOPICS OF CONFERENCE

- ✓ Computational Fluid Dynamics
- ✓ Design for Manufacturing and Assembly
- ✓ PDM, PLM, Collaborative Product Design

CAD/CAM/CAE/FMS/CIMS

- ✓ Reverse Engineering/RPT/3D Printing
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- ✓ IC Engines and Alternate fuels
- ✓ Refrigeration and Air-conditioning
- ✓ Thermal Power Engineering
- ✓ Industrial Engineering
- ✓ Operations Management
- ✓ Optimization Methods
- ✓ Advanced Metal Forming
- ✓ Materials Processing and Characterization
- ✓ Mechatronics, MEMS, NEMS

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National Conference on Recent Advances in Mechanical Engineering and Materials
International Journal of Scientific Research in Mechanical and Materials Engineering
2021 IJSRMME |Volume 4, Issue 7 | ISSN : 2457-0435

Development of Humanoid Robot for Indoor Applications

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ABSTRACT

Humanoid robots are similar to human beings in body structure, movement of joints and motion. Hence, they can perform activities which human beings are capable of doing. In order to replace human being in day-to-day activities one can build cost effective humanoid robot. The agenda of this project is to develop a mechanically well-designed humanoid robot and use this Humanoid to the medical application. Such that the Humanoid robot parts are 3D print technology as it is very economical and delivers strengthened and accurate parts. The completed humanoid looks like similar to the face of human and make eye, jaw and neck movements like human. It contains arms and wrists those work like similar to human as these parts of humanoid robot are controlled by Arduino UNO it acts as a main controller it sends signals to the actuator with reference to the code written in controller board. lower part of the humanoid can be fix on the TurtleBot. as the Turtlebot has the Autonomous Navigation feature so we can move the whole Humanoid robot according to our build map such that it can deliver the needed medication to the patient such that it has built in controlled arm movements.

Keywords - Humanoid robot, TurtleBot, 3D printing, Arduino uno

I. INTRODUCTION

Humanoid Robotics be a Hot topic within the field of science and technology from past years scientists are trying to create various models of humanoid robots. It is an emerging and challenging field within the robotics domain. This paper talks about developing a humanoid robot that looks similar to human being face and expressions.

Japanese have a predilection for humanoid robots. In 1952 a Japanese draftsman, Osamu Tezuka created a human-like robot character, “Atom”, also cited as “Astro-boy” in overseas, that became the favorite idol for Japanese youngsters. Long years ago, Japanese have developed tea serving doll. When tea is placed on the reception table the doll picks the cup of tea and serves it to the guest and comes back to the initial position.

There are many critical conditions where humans cannot work continuously and accurately in those situations, we are able to employ a humanoid to induce the work done. Because the Research and technology grows, we will add new features like sensors, motor drives, Arduino and then on are often wont to build the efficient humanoid robots. Considerable progress has been made within the field

of humanoid robotics that they will achieve the assigned tasks. They are also used for entertainment purposes. Humanoid robot has parts like that resembles same because the human like eyes, mouth, hands, legs and Head. Humanoid robots are used as a pursuit tool in several scientific areas. Researchers have to be compelled to understand the anatomy structure and behavior (biomechanics) to form and study humanoid robots.

Human cognition deals with studying how human beings can learn over a period of time with the help of sensory information. so as to accumulate perception and skills over a period of time. Further, this is used to develop computational models of human behaviour.

II. LITERATURE SURVEY

Md Aktharuzzaman and A.A.Shafie Evolution of Humanoid Robot and contribution of various countries in advancing the research and development of the platform " In this paper a various platforms for humanoid robot development are identified based on evolutionary research on robotics. The paper also depicts a virtual map of humanoid platform development from ancient time to present time.

Parul Gupta, Vinith Tirth and R.K Srivastava, "Futuristic Humanoid Robots: An Overview" In this paper they reviewed successes and failures in the field where humanoid research began. Further, an extrapolation of recent developments is also given where it may take us in the future.

Avishek Choudhury, Huiyang Li, Christopher M Greene and Sunanda Perumalla," Humanoid Robot-Application and Influence" This article highlights the influence of cerebral condition and social interaction on a user's behavior and attitude towards humanoid robots.

III. OBJECTIVES

- The objective of this project is to develop a reliable and nice-looking humanoid platform
- Achieving the Eye movement, Jaw movement of Humanoid robot through servo motor mechanism
- Achieving Neck Movement of the Humanoid through motor gear mechanism
- Achieving controlled Hands and Wrists Movement of the robot by using DC worm gear motors.
- Fixation of the lower part of Humanoid robot on the Turtlebot surface and Autonomous and Targeted movement of the whole humanoid robot using ROS platform.

IV. FABRICATION OF THE HUMANOID ROBOT

The humanoid robot has fabricated to bring it live onto the earth. The fabrication part is divided into mechanical aspects, electrical and electronic aspects and computer programming.

Design Methodology

Functionality of the humanoid robot mainly depends on the mechanical structure. The Designed Humanoid Robot must be Low cost, safe for both experimental and human environments, to be able to do maintenance, highly expandable on both robot hardware and control systems, set center of gravity as high as possible. The Head parts like Skull, eyes, Mouth, and Neck parts are mainly made of ABS plastic. The advantages of using ABS material are it can be easily glued, it also has dimensional stability and stiffness. The designs have been taken from the open source and they are printed by 3D printing method.

3D printing machine

All the parts are 3D printed. Compared to conventional manufacturing 3D printed parts are cost effective. The parts produced by this method also

meet the different specifications which are required to develop humanoid robot. Since the materials like ABS, PLA are readily available for this technique has reached a wide area. The drawings that we have are suitable to be developed with the printer due to the complexity in shape and developing lighter components due to the torque issues.

Fig 1: 3D printed parts of humanoid Robot

Methodology Assembly of Printed Humanoid skull and neck parts.

Once the different parts of head and neck are obtained by 3D printing process, they are joined with the help of nuts and bolts. servomotors are used in suitable position where we require movements like eyes movement and neck movement.

Fig 2: Side view of head

Fig 3: Head and Neck part

It is very expensive to 3D print the upper body and the arms of the robot. So, we Selected the suitable robot body (mannequin) that contains the robot arms and wrist and gear DC motor with micro-turbine worm. This motor has sequential gears. It also has the capacity to carry high load. The reduction ratio of this gears is large and it is connected to potentiometer which helps in reaching accurate position. After completion of Arms and Wrists parts mounting. the Fixation of lower body of the Humanoid robot on the woodened surface of the TurtleBot by fastening nuts and bolts.

Fig 4: The humanoid robot with Fixed complete assembly,

TurtleBot -TurtleBot is a Kobuki mobile platform made by the Yujin robot company. TurtleBot rests on the ground on 2 wheels and a caster. the lower portion of the turtlebot is designed as a differential drive base, which insists that once when the TurtleBot is moving, the move rate of the wheels is controlled severally.

V. COMPUTER PROGRAMMING

Our Humanoid robot consists of several Servo motors these can be controlled through well programmed Arduino Board which acts as a controller The Arduino platform can control the hardware as long as if it is programmed well. The program is written in an Arduino UNO and then it is fed into the Arduino board through a USB connector from the computer. From there on the micro controller takes control of sending inputs to the servo motors and receives feedback from the encoders of the servo motors.

Arduino uno:

The Arduino Uno is a microcontroller board supports the ATmega328t. It has twenty digital input/output pins. There are six pins which can be used for PWM output. There are six pins which can be used for analog input, a 16 MHz resonator, a USB affiliation, an influence jack, associate in-circuit system programming (ICSP) header, and a push button. It just contains everything required to call this as a microcontroller merely connect it to a portable computer with a USB cable.

Fig 5: Arduino uno

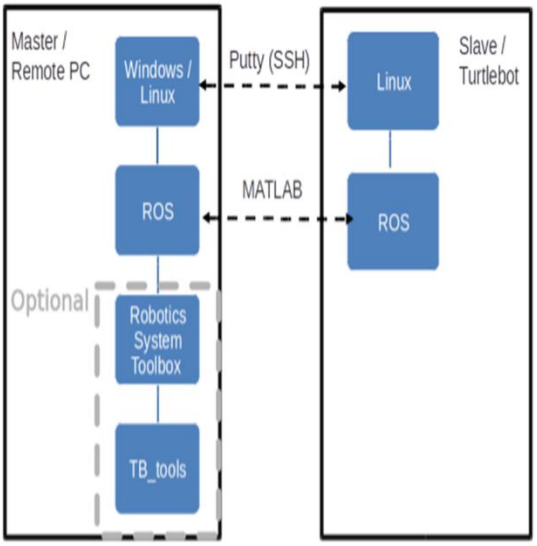

Fig 6: ROS architecture

ROS:

The robot operating system (ROS) is be a versatile open source framework for writing robot software. And robots to do things. It consists set of tools, libraries, that aim to change the task of making

advanced and strong robot behavior across a good form of robotic platforms.it contains nearly 2,000 software packages. Approximately over 80commerciallyavailable robots are supported. ROS provides. ROS provides the all parts of the robot software that we would otherwise we have to write.

Indoor Applications of humanoid robot:

Hotels: Humanoids can perform more useful work in indoor applications like hotels restaurants coffee shops etc. they can be used as waiter or server to take orders from the customer and to deliver meals to designated tables by navigation. when customer arrives, humanoid robot greets them and shows the menu in its screen. once the order is ready and humanoid can deliver these orders to the designated tables using the predefined path for the particular table where the customers are seated. Implementing humanoids can also act as non-contact service to the customers during pandemic situations like covid-19.

Assisting aged people in home: Application of AI has enabled humanoid robots to find its usefulness in health care sector. Humanoids are being used to take care of the aged people in home. One can easily monitor the activities of aged people from a distant place.

Student screening at the entry of college: During the covid time these can be placed near each department or classroom to monitor the temperature and any related symptoms of the students. The data from these is transferred to cloud and collected by different departments to monitor student health condition. Similarly, these can be adopted where people gather in large number which becomes difficult to monitor each one's health care.

Greeting people in function: Apart from health care and educational aspects it is also used for entertainments. It is used to greet people in functions. Humanoid have movements similar to normal human being. It can greet people by hand shaking, conveying wishes through voice or giving a Boquete to a person.

VI. CONCLUSION

Our Primary goal is to Design a well-designed and Efficient Humanoid robot that can mimic human movements like eye movement, neck movement, jaw movements, hand and wrists movements are successfully achieved. And the next part like as the lower humanoid robot body is fixed to the Turtlebot surface and by using Robotic operating system in that by implementing Navigation and Autonomous navigation feature. The Autonomous movement and moving the whole humanoid robot to the targeted place achieved successfully.

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National Conference on Recent Advances in Mechanical Engineering and Materials
International Journal of Scientific Research in Mechanical and Materials Engineering
2021 IJSRMME |Volume 4, Issue 7 |ISSN : 2457-0435

Design and Analysis of Centrifugal Pump Impeller by Finite Element Analysis

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ABSTRACT

The Centrifugal pump is a device which is mostly used for transporting liquid from lower level head to higher level head. Centrifugal pumps are used for, sewage, oil refineries, hydraulic power services, food processing factories, mines, chemical plants, irrigation, water supply plants and steam power plants because of suitability in various practical services. In centrifugal pumps the mechanical energy will be converted into hydraulic energy. The main components of centrifugal pump are casing and impeller therefore; they must be designed carefully for best performance of pump. The main goal of this work is to present design and analysis of centrifugal pump impeller by finite element analysis for four different materials Mild steel, Stainless steel, Aluminum alloy and Epoxy glass fiber composite material. Centrifugal pump impeller is modeled into 3D using Solid works 2015, using Ansys Software 2016 impeller material properties are given Stresses and Deformation in X, Y, Z directions are investigated. A structural analysis will be carried out to investigate the stresses, strains and displacements of the centrifugal pump impeller in Ansys Workbench. The paper gives static analysis of Impeller of different materials to check strength and deformation of Pump and found that the impeller with Epoxy glass fiber composite material is best compared to other material like MS, SS, and AA.

Index Terms - Centrifugal Pump Impeller, Design and Analysis, Weight Less Impeller, Ansys, Solid Works, Mild Steel EN-8, Stainless Steel 304, Aluminum Alloy 6064

I. INTRODUCTION

Centrifugal pump is rotor dynamic pump uses a rotating impeller to increase the pressure of fluids. Centrifugal pumps are mostly used to move liquids through piping systems. The fluid will enter the pump impeller near to the rotating axis will be accelerated by the impeller, which will flow radially outward into a diffuser volute chamber i.e. casing or diffuser. Its main purpose is to convert energy of a prime mover (an electric motor or turbine). First into velocity or kinetic energy and then into pressure energy of a fluid that is pumped. Centrifugal pumps are mostly used for large discharge through smaller heads. The Centrifugal pumps convert mechanical energy from a motor to energy of a moving fluid and some of the energy will go into kinetic energy of fluid motion and some into potential energy and will be represented by lifting the fluid against gravity to a higher level or fluid pressure.

[1] A Syam Prasad, B V V Lakshmipathi Rao, A Babji, Dr P Kumar Babu, “Static and Dynamic Analysis of a Centrifugal Pump Impeller” Alloys are playing one of major role in many engineering applications. They are offering outstanding mechanical properties, physical properties, flexibility in design capabilities and ease of fabrication. Few advantages include light weight,

impact resistance and excellent fatigue strength and corrosion resistance. This paper studies have carried out on static and modal analysis of a centrifugal pump impeller which is made of 3 different alloy materials. (I.e. Inconel alloy 740, Incoloy alloy 803, Warpaloy)

[2] Karthik Matta, Kode Srividya, "Static and Dynamic Response of an Impeller at Varying Effects" An impeller is a rotating component of a centrifugal pump, usually made of iron, aluminum, steel, bronze, brass, or plastic. The modeling of the impeller was done by using solid modeling software that is CATIA V5 software. It is proposed to design a blower with composite material, analyze strength and deformation using FEM software. In order to validate the effectiveness of composites and metal blower and impeller using FEA packaged i.e. ANSYS Workbench.

[3] G. Kalyan, K.L.N. Murty. "Design and Optimization of Centrifugal Pump Guide Vanes" In this paper an impeller of a centrifugal pump is designed and modelled in 3D modeling software. Materials used are steel and aluminum and the optimization of the impeller design is done by observing the results obtained from the analysis performed. The results considered are stress frequency velocity pressure flow rates. Analysis is done in ANSYS software 2016. The observered results shows the structural analysis result of stresses by increasing number of blades and increasing the angle of blade

[4] Pramod J. Bachche, R.M.Tayade "Finite Element Analysis of Shaft of Centrifugal Pump" In this paper study Shaft of centrifugal pump for static and dynamic analysis. The shaft is analyzed by using finite element analysis technique for stresses, strains and deflections. The total work is carried out in two stages in first stage is static analysis. In this stage pump the shaft is analyzed for stresses, strains and deflection and same results are verified using graphical integration method. And second stage for dynamic analysis, in this second stage result obtained by static analysis is used to calculate dynamic forces coming in pump shaft. Again shaft is analyzed in dynamic input condition and results are verified by using graphical integration method.

[5] S.Rajendran and Dr. K Purushothaman "Analysis of centrifugal pump impeller using ANSYS-CFX" In this paper analysis of centrifugal pump impeller design is carried out using ANSYS-CFX. It is most common pump used in industries and domestic application. The complex internal flow in centrifugal pump impeller can predict by ANSYS-CFX. The centrifugal action of impeller accelerates the liquid to high velocity, transferring mechanical energy to the liquid. The flow pattern, pressure distribution in blade passage and blade loading of centrifugal pump impeller. Centrifugal pump impeller without volute casing is solved at a designed mass flow rate is high. The total efficiency of pump will increase by 30%.

II. OBJECTIVES OF STUDY

1. Modeling of Centrifugal Pump Impeller using Solid works software 2015.
2. To check strength of centrifugal pump impeller and weight reduction by static analysis utilizing Ansys workbench 2016 for different materials Mild Steel EN8, Stainless Steel 304, Aluminum alloy 6061 and Epoxy Glass Fiber.

III. METHODLOGY

Modelling of centrifugal pump impeller by utilizing CATIA V5 Software

- **ASSEMBLY OF CENTRIFUGAL PUMP IMPELLER**

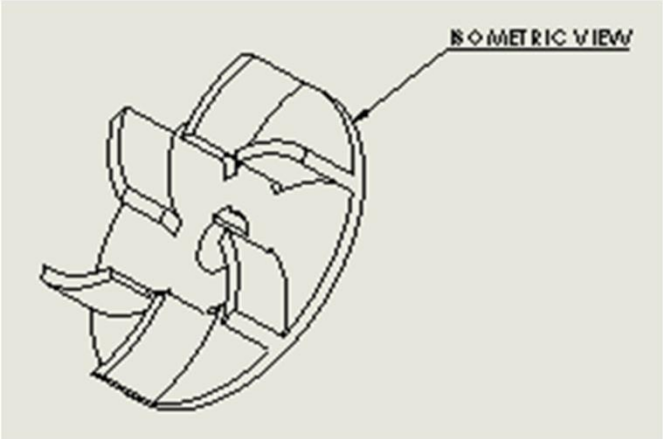

Fig. 1 Assembly of Centrifugal Pump Impeller

➢ GEOMETRY OF CENTRIFUGAL PUMP IMPELLER

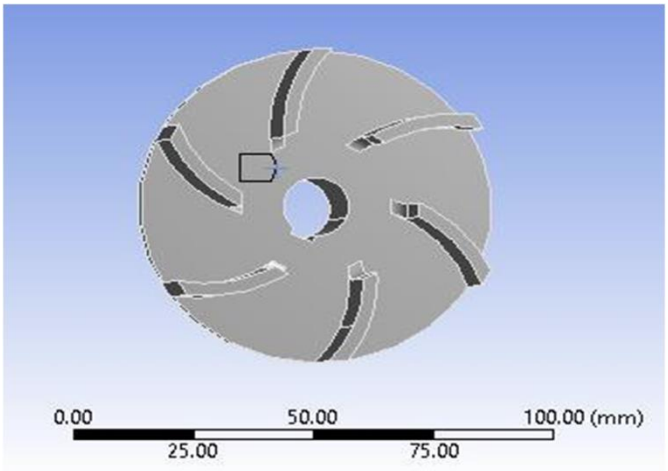

Fig. 2 Geometry of Centrifugal Pump Impeller

➢ FEA MODEL OF CENTRIFUGAL PUMP IMPELLER :

In Mesh Generation: Finite element analysis is carried out; the model used compulsory divided into a number of small parts which is known as finite elements. Since the model will be separated into various discrete parts, Finite element analysis can also be called as discretization method. In different terms, a mathematical net or mesh will be required to carry out a finite element analysis. If the system under validation is 1Dimensional in nature, we use line elements to represent geometry and to carry out analysis. If the problem can be described in two dimensions, then a 2Dimensional mesh will be required. Then, correspondingly if the problem is complex and a 3Dimensional representation of the continuum is required, then we 3Dimnesional mesh is used. Area elements can also be triangular or quadrilateral in shape. The selection of the element order and shape is mainly based on considerations relating to the complexity of nature and the geometry of the problem being modelled in Ansys Workbench. Membrane elements will not have thickness. As a result there will not be bending stiffness. The loads can only be carried in the element plane. There are special elements, which can facilitate accurate modeling of thick plates. If the deflection is greater than the plate thickness, then the membrane action should be considered and so shell elements should be considered. Shell element nodes have five degrees of freedom the missing is the in-plane rotational freedom (also called as the drilling freedom). Solid elements come in different varieties. Axi- symmetric elements are used to describe the cross- section in an axially symmetric part.

➢ VOLUME MESHING

3Dimensional elements take the form of cubes called hexahedrons, 3Dimensional triangles called tetrahedrons and 3Dimensional wedges known as pentahedrons. Decisions on element selection hinge on understanding the role of the element order of interpolation and shape. The Modeling of 3D-Elements is the most flexible approach. These types of elements are used for thick structures that have neither an axis of symmetry nor a constant cross section. The Solid modeling will almost make analysis preparation a bit easier. Meshing and solving can take a long time particularly if the structure is thin-walled i.e. large number of elements are required to produce a mesh in FEA.

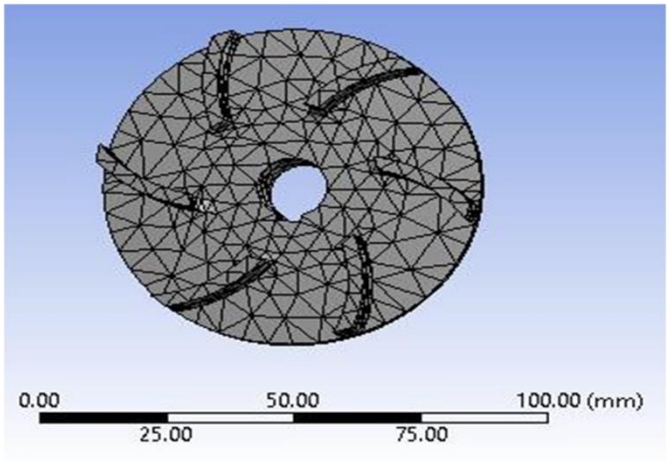

Figure 3 FEA Model of Centrifugal Pump Impeller

Table 1 Number of Nodes and Elements of Centrifugal Pump Impeller

Statistics	
Nodes	3491
Elements	1662
Mesh Metric	None

- **SUPPORT**

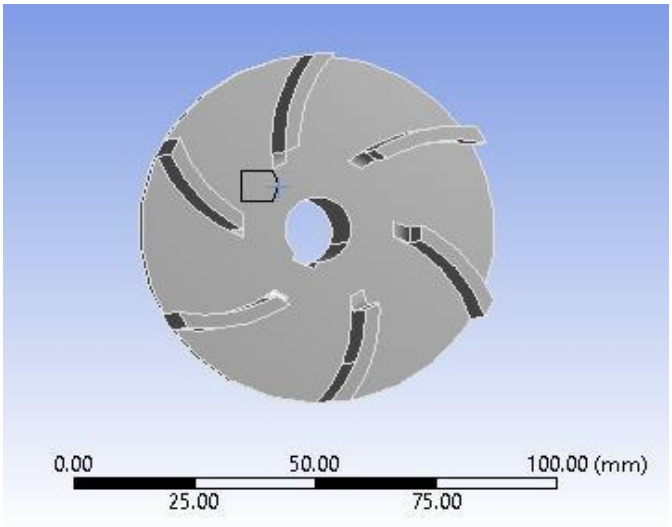

Fig 4 Fixed Support of Impeller

- **MOMENT**

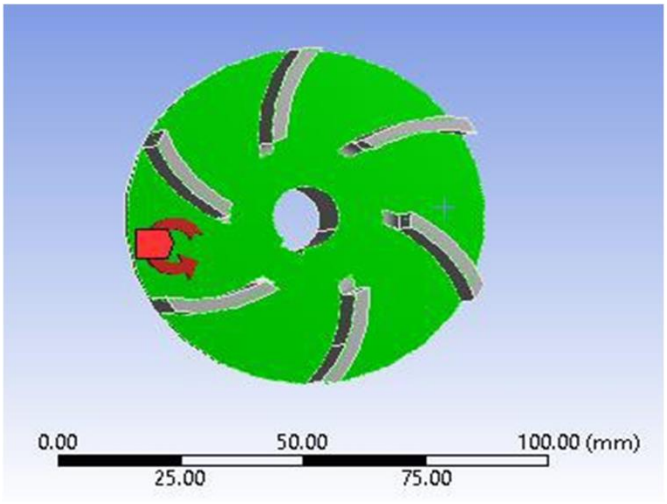

Fig 5 Moment applied at Impeller

IV. STATIC ANALYSIS OF CENTRIFUGAL PUMP IMPELLER

- **Procedure For Static Analysis In Ansys 2016 Software:**

1. Build the FE model
2. Define the material properties such as young's modulus, density and poisson ratio etc.
3. Apply boundary condition and pressures.

- **ANSYS 2016:**

ANSYS Work bench is a software platform where analysis is carried out i.e. Finite Element Analysis activities. The workbench allows organizing all related analysis files, databases under the same frame work.

The ANSYS Workbench platform provides users to create new, faster processes and efficiently interact with other tools like update Computer Aided Drawings systems. In this particular platform working on Metaphysics simulation would become easy. Those performing a structural simulation use a graphical interface i.e. called the ANSYS Workbench Mechanical application which employs a tree like

navigation structure to define all parts of their simulation, geometry, mesh, loads, boundary conditions, connections, and results. By using ANSYS workbench 2016 the user can save time in many of the task performed during simulations. The bi-directional links with major update Computer Aided Drawings systems offer an efficient way to update Computer Aided Drawings geometries along with design parameters.

- **Static Analysis For Equivalent (Von-Misses) Stress:**

Static analysis of centrifugal pump impeller is done using Finite Element Analysis which is the main part of centrifugal pump. The, Impeller is chosen as main part of centrifugal pump for the static analysis because Centrifugal Pump Impeller is core part of centrifugal pump and all the performance of blower is depended upon it . The Analysis is done for the material like MS EN-8, SS 304, Al Alloy 6064 and Glass fiber in order to check Equivalent stresses and its corresponding deformations induced in each material. Analysis is done for the material MS EN-8, SS 304, Al Alloy 6064 and Glass fiber respectively, in order to check deformations induced in each material and check equivalent stresses.

V. STATIC ANALYSIS OF MS EN-8 PUMP IMPELLER:

- **Total Deformation:**

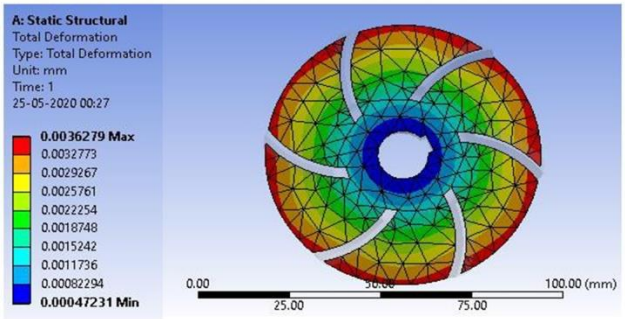

Fig 6 Total Deformation of MS EN-8 Pump Impeller

- **Equivalent Stresses:**

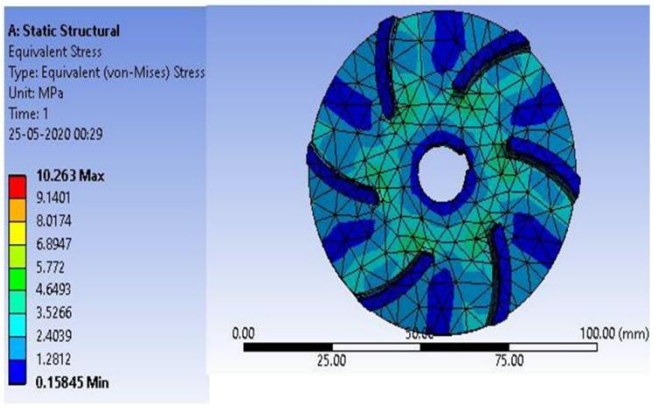

Figure 7 Maximum Stress induced in MS EN-8 Pump Impeller

VI. STATIC ANALYSIS OF Al PUMP IMPELLER

- **Total Deformation:**

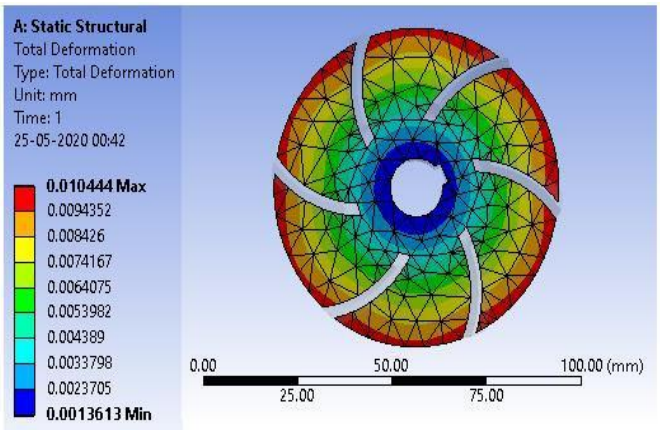

Figure 8 Total Deformation of AA Grade-6064 Pump Impeller

- **Equivalent Stresses:**

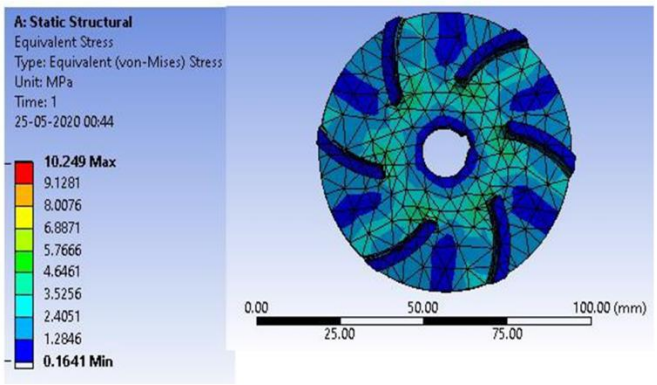

Figure 9 Maximum Stress induced in AA Grade-6064 Pump Impeller

VII. STATIC ANALYSIS OF STAINLESS STEEL PUMP IMPELLER

➢ **Total Deformation:**

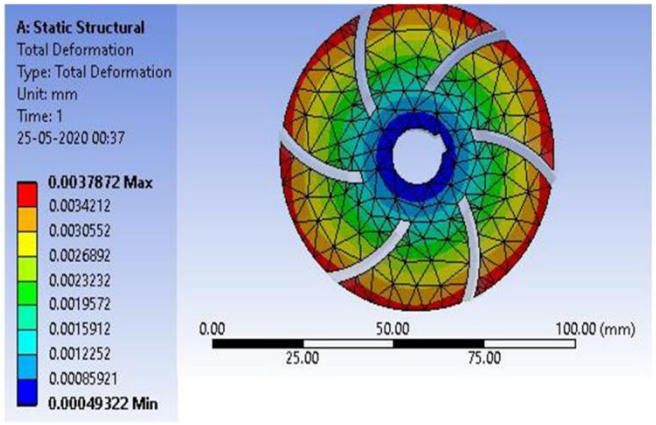

Figure 10 Total Deformation of SS Grade-304 Pump Impeller

➢ **Equivalent Stresses:**

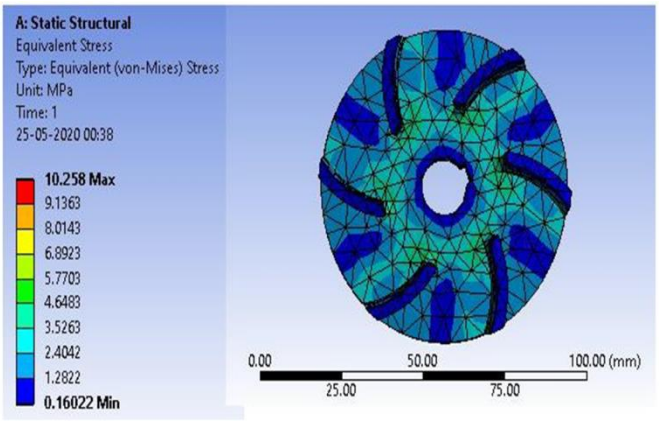

Figure 11 Maximum Stresses in SS Grade-304 Pump Impeller

VIII. STATIC ANALYSIS OF COMPOSITE MATERIAL (E-GLASS/EPOXY) PUMP IMPELLER

➢ **Total Deformation:**

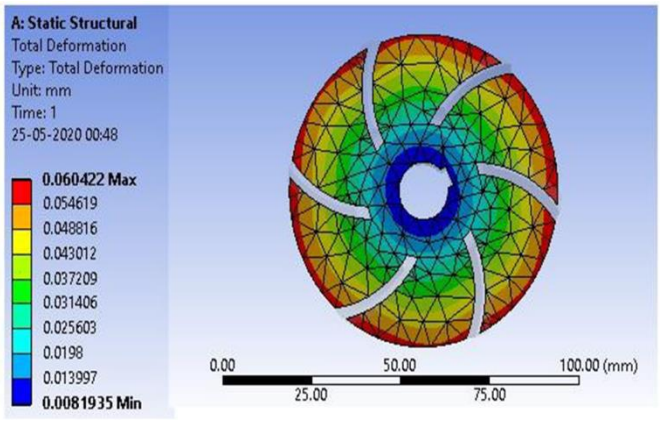

Figure 12 Total Deformation of E-Glass Pump Impeller

➢ **Equivalent Stresses:**

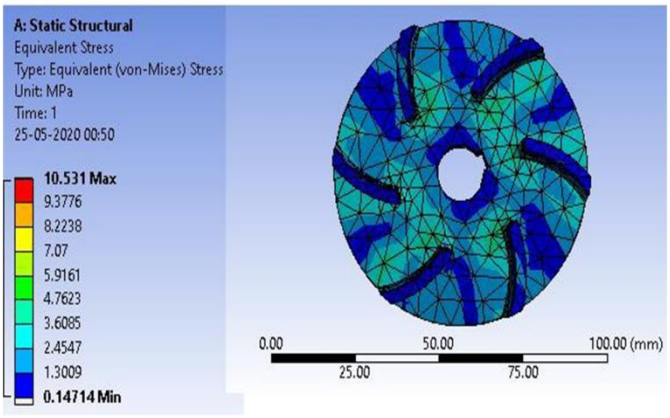

Figure 13 Maximum Stresses induced in E-Glass Pump Impeller

IX. RESULTS & DISCUSSIONS:

The analysis of centrifugal pump impeller has been done for all the four materials viz. MS EN-8, SS Grade-304, aluminum alloy Grade 6064 and Composite material (E- glass fiber). The comparison of properties and analysis results is shown in the table 2.

Table 2 Results of Centrifugal Pump Impeller

Sl. No	Material	Deformation (mm)	Max. Stress (MPa)	Weight (Kg)
1	Mild Steel EN8	0.0036	10.26	2.85
2	Stainless Steel Grade- 304	0.0037	10.25	2.73
3	Aluminium Alloy Grade- 6061	0.0104	10.24	1.24
4	Composite material (E-glass fibre)	0.0604	10.53	0.87

Most of the centrifugal pump impellers are made up with Mild Steel EN8 which results in density. This is the main cause for high weight of the pump. It is observed from finite element analysis results that the stresses will be maximum at the shaft location.

From the comparison of Finite Element Analysis, it is observed that glass fiber is the material which is having the less weight, good strength and non-corrosive properties compared to other materials analyzed shown in table. Epoxy Glass Fibre is best suited alternative material for centrifugal pump impeller and is expected to perform better with a good amount of weight reduction
i.e. (0.87 Kg).

X. CONCLUSION

It is observed that all the materials will have stress values less than their respective permissible stress values. By doing static analysis of pump impeller it is observed that, the maximum deflection induced in Epoxy glass fiber material is 0.0604 mm, which is in permissible safe limits. The maximum induced stress for the Epoxy glass fiber is 10.53 MPa which is less than the allowable stress i.e. working stress by considering factor of safety (72 GPa).Hence the design is safe based on strength.

From the table 2 results above it is observed that weight of the Epoxy Glass Fiber (0.87 Kg) impeller material is minimum as compared to Mild Steel EB-8 (2.85 Kg), Stainless Steel 304 (2.73 Kg) and Aluminum Alloy material 6064(1.24 Kg), hence weight of the centrifugal pump impeller is reduced (optimized). It is observed that

maximum deformation takes place at the periphery of the centrifugal pump impeller (10.53 MPa). The deformation in Alloy Material is less (10.24 MPa). The Epoxy Glass fiber material which is having the less weight (0.87 Kg), deformation (0.0604) it is best suited alternate material for centrifugal pump impeller and is expected to perform better with constructive amount of weight reduction.

XI. FUTURE SCOPE

- Dynamic analysis can be performed for pump impeller.
- Modal analysis can be performed for pump impeller for determining natural frequency.
- Computational Fluid Dynamics analysis of the centrifugal impeller can be performed.
- Different way of development is by increasing the number of vanes.
- In this design as the numbers of vanes on diffuser were six, impeller with three, impeller with four vanes could be used.

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National Conference on Recent Advances in Mechanical Engineering and Materials
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2021 IJSRMME |Volume 4, Issue 7 |ISSN : 2457-0435

Design and Analysis of Land Leveller Suspension

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ABSTRACT

In The current year's traditional product technology of farming device have been leading to the deterioration of soil health and declining form profitability because of high enter of water and labor. Land levelling improves water coverage in the area, can improve irrigation performance. There might be lower in water intake and huge boom inside the crop yield and first-rate because of suitable field leveling, inside the latest generation the laser land leveler has been used, laser land levelling is one of the modern strategies which allows in the control of water and soil with the aid of decreasing the quantity and time required for irrigation. It is used only for professional character and hard setup. The primary troubles had been the effectiveness of laser land levelling as a water-saving tool in the new context of land use and possession, affordability of laser land levelling for farmers, and the economic viability of this area. So, over this affordability, the leveler becomes format and editing the existing device by means of using putting in suspension to it and have a look at to enhance the performance and reduce the price.. The suspension allows to degree the maximum and minimum land variation, that enables to set in the moderate stage, to perform the uniform pass the place of land. On this layout, sensors are used to reap the precision of component and similarly set the level automatically. This design normally requires to conquer professional men and women, i. e. Any person can set up the aspect and operate the device easily and used for distinctive tractors (2w & 4d).

I. INTRODUCTION

An unevenness of the soil surface has a chief effect at the germination, stand and yield of flowers thru nutrient water interaction and salt and soil moisture distribution sample. Land levelling is a precursor to acceptable agronomic, crop control practices and soil. Conserving technologies perform higher on well leveled and laid-out fields. Farmers apprehend this and therefore dedicate extensive attention and resources to levelling their fields properly [1]. However, traditional methods of levelling land are not best greater bulky and time-eating but greater steeply-priced as well. Very regularly most rice farmers level their fields beneath ponded water situations. The others dry level their fields and take a look at the stage with the aid of ponding water. Hence in the process of having true leveling in fields, a considerable amount of water is wasted. It's far a not unusual knowledge that most of the farmers follow irrigation water until all of the parcels are completely wetted and covered with a thin sheet of water[2]. Research has indicated that an extensive (20-25%) quantity of irrigation water is lost all through its utility at the farm because of terrible farm designing and unevenness of the fields. This problem is extra pronounced inside the case of rice fields. An unevenness of fields ends in inefficient use of

irrigation water and also delays tillage and crop establishment options. Fields that are not degree have choppy crop stands, elevated weed burdens, and choppy maturing of vegetation. A majority of these elements tend to contribute to decreased yield and grain first-rate which lessen the potential farmgate profits. Powerful land leveling is supposed to optimize water-use efficiency, improve crop establishment, lessen the irrigation time and effort required to manage the crop[3]. The manual for laser land leveling seeks to explain the advantages of land leveling in fields, especially rice fields, and assist increase the abilities of farmers and operators in using laser technology to gain a degree discipline surface. It is also meant to enable the customers to discover and understand the operating of the diverse components of a laser- managed land leveling system; undertake a topographic survey using a laser gadget; set up and use a laser-controlled levelling machine and troubleshoot a laser- managed levelling gadget. It's far hoped that the users (farmers and provider vendors) will discover this manual useful in adopting this crucial useful resource maintaining generation as a precursor to several different stepped forward agronomic, soil, and crop management practices[4].

A. Benefits of land leveling

Effective land levelling reduces the work in crop establishment and crop management and will increase the yield and excellent.

Degree land improves water coverage that l improves crop established order weed issues l improves the uniformity of crop adulthood l decreases the time to complete obligations l reduces the amount of water required for land preparation [6].

B. Yield

Studies have proven a massive boom in rice yield due to good discipline levelling. The following desk shows the results of land levelling experiments conducted in Cambodia between 1996 and 1999[8].

Table 1. Results of land levelling experiments conducted by CIAP in Cambodia, 1996-1999.

Year	Rice Yield (t ha^{-1})	
	Leveled fields	Unleveled fields
1996	3.40	2.67
1997	2.27	1.46
1998	2.72	2.36
1999 (CARDI)	2.34	2.00
Average	2.72	2.19

The above table shows that, for the same rice varieties and the same fertilizer input, the average increase in crop yield was 24% or 530 kg ha–1. In two experiments conducted at different localities, a strong correlation was found between the levelness of the land and crop yield. This correlation is shown in Fig. 1 [8].

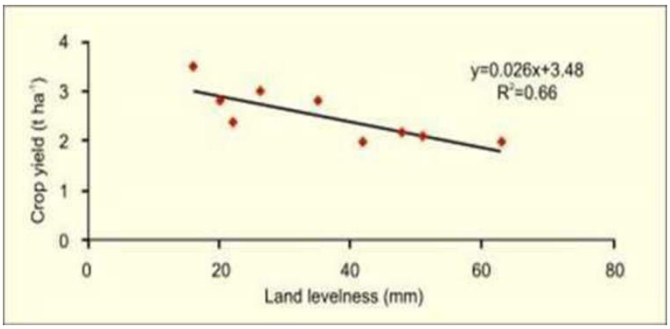


Fig 2. Graph showing a correlation between levelness of land and crop yield.

C. Weed Control

Land leveling increases yield. A massive part of this growth is due to advanced weed management. Advanced water insurance from better land leveling reduces weeds by up to 40%. This reduction in weeds results in much less time for crop weeding. A discount from 21 to 5 labor-days according to hectare is carried out. This represents a 75% decrease within the labor required for weeding[11].

Fig 1: Manual weeding operation.

D. Farm Operation

Land leveling makes possible the use of larger fields. Large fields grow the farming area (fig. 2) and enhance operational performance. Increasing area sizes from zero. 1 hectare to zero. Five hectare increases the farming region via among 5% and seven%. This boom in a farming place gives the farmer the option to reshape the farming place that may lessen working time with the aid of a discount of as much as 16 person-days per hectare 10% to 15% [6].

II. THEORY AND CONCEPTS

A. Options for Land Leveling

Draft animals, such as buffaloes and oxen, 2wheel tractors, or 4-wheel tractors can all be used as power sources to level a field. Different systems require different field conditions and operating time to complete the task.

Fig 3.

(a) conventional method of land levelling using animal- drawn timber log.

(b) mechanized land levelling using a tractor-drawn planter.

Draft animals and a pair of-wheel tractors the usage of harrows and leveling boards. These levelling strategies require overall water coverage of the sphere and require 7 to 8 days for a 2wheeled tractor and 12 days according to a hectare of land the usage of draft animals. Four-wheel tractor using rear-set up tractor blades or drag buckets. Four-wheel tractors are very effective for levelling each wet and dry fields. Moist fields are high-quality levelled with a rear-established tractor blade. Dry fields are first-rate levelled with the usage of hydraulically operated drag buckets. Tractor painting fees are dependent on the tractor's ability and the amount of soil to be moved. It takes approximately eight hours to level 1 hectare with a rear- mounted tractor blade. This reduces to approximately four hours when using a drag bucket[11].

B. Effects of Uneven Distribution of Land

The not unusual practices of irrigation in intensively cultivated irrigated regions are flood basin and check basin irrigation structures. These practices on traditionally levelled or unlevelled lands lead to waterlogging situations in low-lying areas (fig. 4a) and soil water deficit at higher spots (fig. 4b). Sizable

quantities (10-25%) of irrigation water are misplaced in the course of application on the farm because of negative control and uneven fields. Conservation agriculture practices coupled with precision land levelling facilitate uniform water utility and reduce deep percolation losses
of water[13].

Fig 4.

(a) Waterlogging in a wheat field.
(b) Uneven distribution of irrigation water under traditional land levelling.

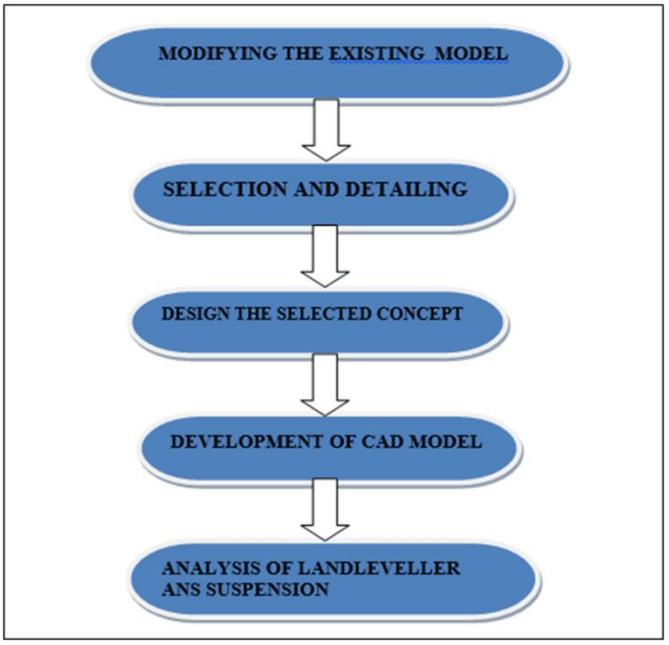
III. PROJECT OBJECTIVES AND PROJECT METHODOLOGY

A. Project Objectives

An exhaustive literature survey led to formulate the objectives for the present study of the model.
Objectives are as below

- Design & Modify the existing land leveller model by fitting free suspension to it.
- To conduct an analysis on suspension spring and leveller bucket in Ansys software.
- To conduct the levelling experiment for different soil conditions.

B. Project Methodology



Project Methodology Flow Chart

Fig shows a flowchart connected to Methodology followed during project execution. It consists of 5 steps

- Modifying the existing land levelling system.
- Selecting and detailing the selected concept.
- Designing the selected concept.
- Using CATIA V5 R20 software development of the CAD model.
- Analysis of Land Leveler & Suspension using Ansys Workbench software 17.2.

IV. MODIFICATION OF THE EXISTING MODEL

A. Existing land leveler

The leveling bucket may be either linkage set up or pulled with the aid of the tractor's drawbar. Pull kind structures are favored as it's miles less complicated to connect the tractor's hydraulic device to an outside

hydraulic ram than hook up with the internal manipulate device utilized by the linkage machine.

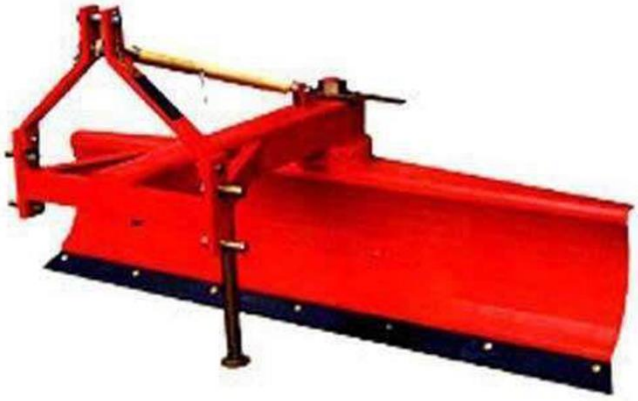


Fig 5: Existing land leveler

This fig 5 shows the present model of a land leveller, which can only mount in a particular level and drag pulled by the tractor's drawbar. This levelling method lags in the precision of land level irrigation.

B. Modified Model of Land Leveller

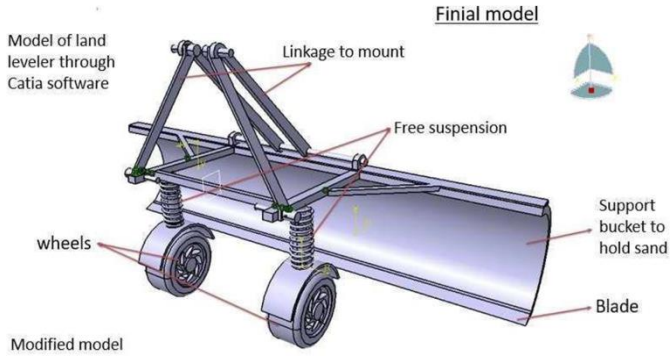


Fig 6: Modified Model of Land Leveller Using Catia V5 R20 Software

The Design of modifying the existing system by installing Suspension to it and analyze to improve the performance and decrease the cost. The Suspension helps to measure the maximum and minimum land variation, which helps to set in moderate level, to perform the uniform cross the area of land. In this design, sensors are used to achieve the precision of components and further set the level automatically. This design overall requires to overcome skilled persons, i.e., any person can set up the component and operate the system easily and used for different tractors (2W & 4D).

Table 2: properties of materials used for the land leveller

PARTS	MATERIAL	GRADES
Leveller Body	Iron	EN – GJS – 600-3 EN – GJS – 500-7
Blade	Carbon Steel	AISI 1065
Suspension	Steel Alloy	ASTM 1070
Wheel	Rubber	

C. Drafting

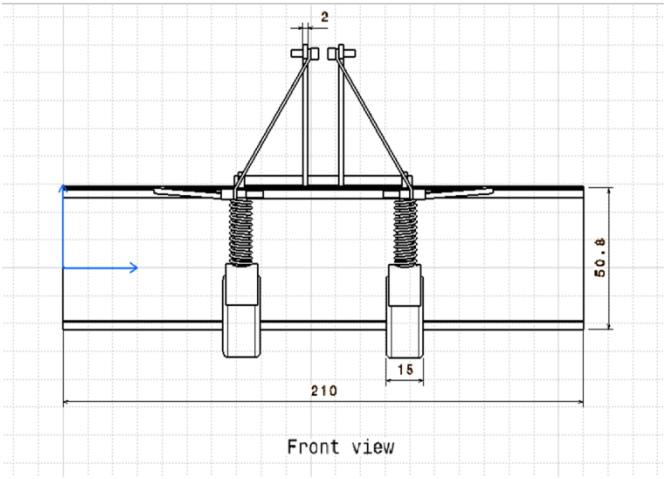


Fig 7: Front view

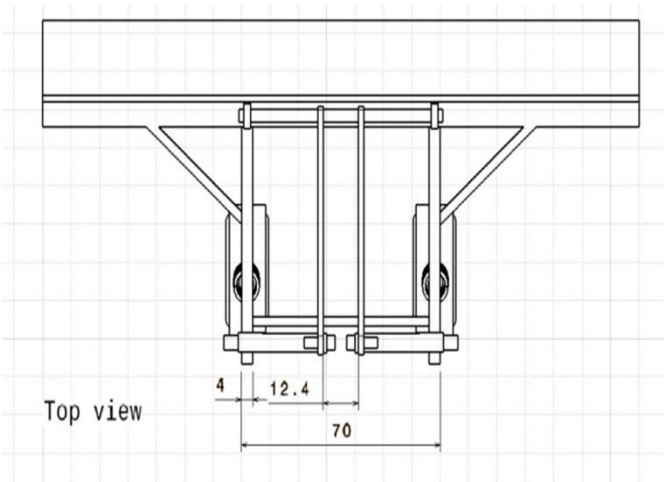


Fig 8: Top view

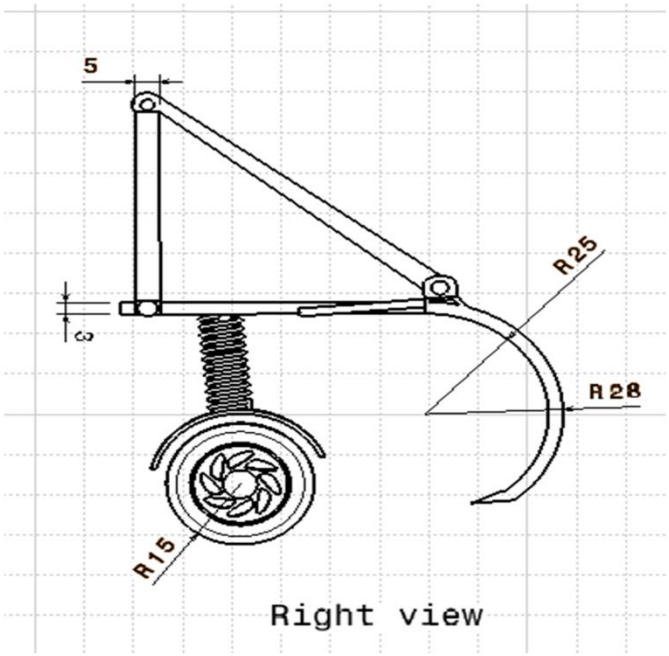
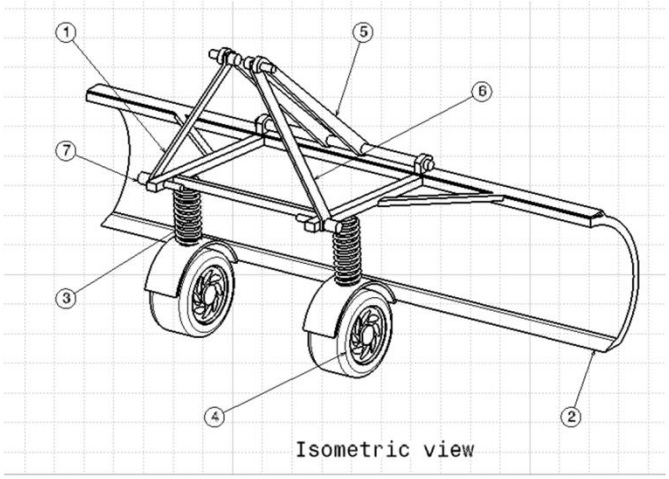


Fig 9: Side view



Sl no:	Part Number	Quantity
7	Bolt	4
6	Connecting strip to mount	2
5	Connecting strip	2
4	Wheel	2
3	Suspension	2
2	Blade	1
1	Leveller bucket	1

Bill of materials:

Fig 10: Iso view

V. RESULTS AND DISCUSSION

The static analysis is done in different loading conditions at assumptions of minimum and maximum load conditions for Suspension and Leveller blade to find max shear stress, max total deformation, and max stress analysis.

A. Analysis of A Suspension Spring at Different Load Conditions.

a. Shear stress analysis

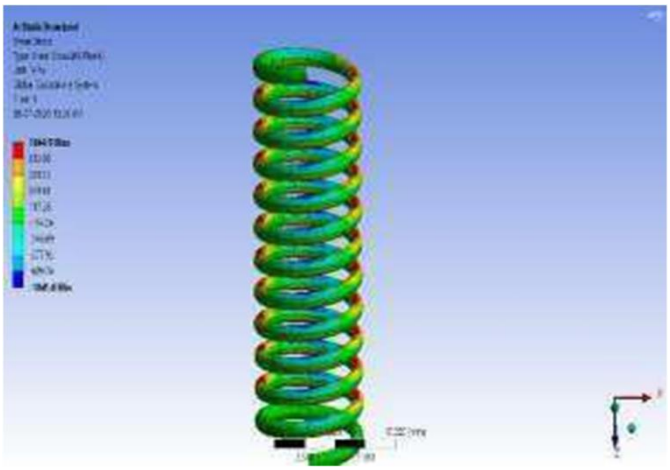


Fig 11. Shear stress analysis of a suspension spring at different load conditions.

b. Stress analysis.

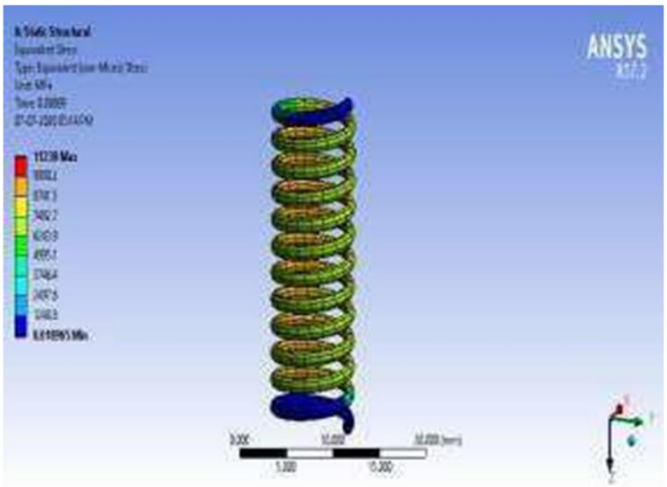


Fig 12. Stress analysis of a suspension spring at different load conditions

c. Total deformation

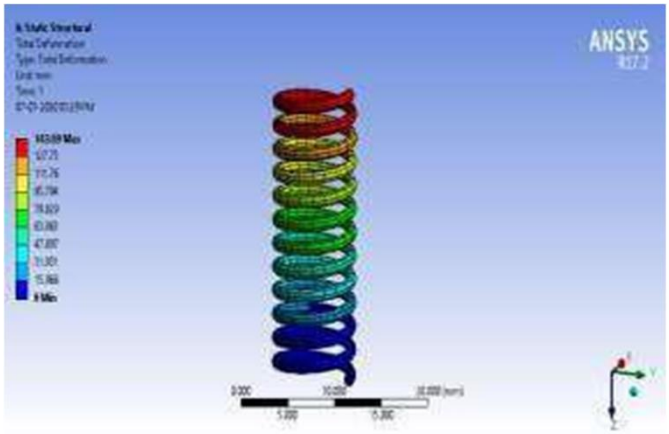


Fig 13. Total deformation of a suspension spring at different load conditions

Result for Suspension Spring at Different Load Conditions.

Table 3: Spring at Different Load Conditions

Sl no:	Load (N)	250	350	450
1	Von-mises stress (Mpa)	11239	15735	20230
2	Total Deformation (mm)	143.6	201.17	258.64
3	Shear Stress (Mpa)	749.61	1044.9	1340.2

B. Analysis of A Leveler Blade at Different Load Condition.

a. Stress analysis

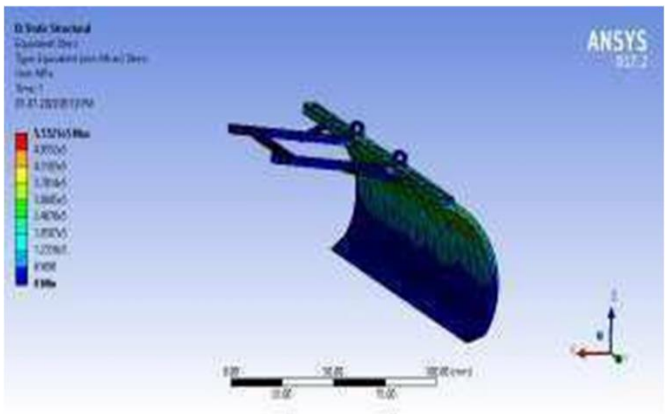


Fig 14: Stress analysis of a Leveller Blade at Different Load Condition.

b. Total deformation

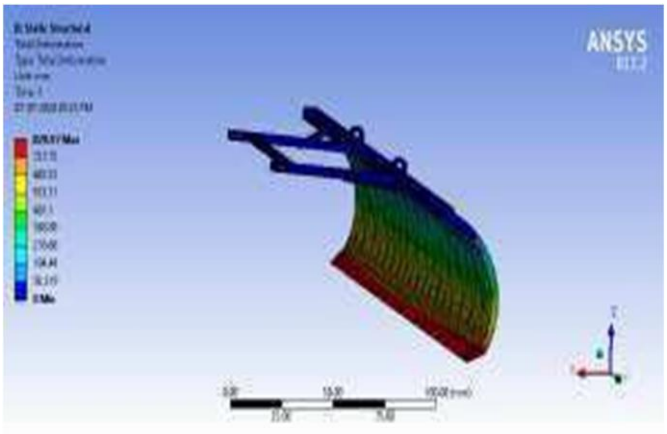


Fig 15: Total deformation of a Leveller Blade at Different Load Condition.

Result for Leveler Blade at Different Load Condition.

Table 4: Leveler Blade at Different Load Condition

Sl no:	Load (N)	500	1000	1500
1	Von-mises stress (MPa)	$2.776e^5$	$5.5521e^5$	$8.3281e^5$
2	Total Deformation (mm)	829.97	1659.9	2489.9

VI. CONCLUSION

The cost of the land Leveller is reduced up to 30%, it reduces the water requirement by 21% & For the proper Land level increase the yield of the crop by 20%. There will be less effect on Land laveller for different soil conditions & the designed Land Leveller can be used for different tractors (2W and. 4D). The static analysis of the suspension springs and leveling blade were performed. The analytical results were calculated and determined for three different loading condensation and are represented in tabular form under each load. By performing the static analysis, the max shear stress and the max total deformation under constant static load were determined and these results agreed well with the analytical results.

VII. FUTURE SCOPE

- Use of Hydraulic Suspension instead of Spring Suspension.
- Install the sensor to determine the Maximum and Minimum variation in Leveling and automatically set the Leveller blade to a moderate level.
- Check the Land Leveller for different speed conditions with different tractors.
- Conduct Levelling experiment for small and large areas of land.

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National Conference on Recent Advances in Mechanical Engineering and Materials
International Journal of Scientific Research in Mechanical and Materials Engineering
2021 IJSRMME | Volume 4, Issue 7 | ISSN : 2457-0435

IoT Based Kitchen Inventory Tracking System

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ABSTRACT

Web of Things innovation is changing our day-by-day life by implanting sensors and actuators in all the machines we use. The percepts from sensors are brilliantly controlled to settle on better choices. Our framework is presenting the utilization of Internet of Things innovation in the kitchen. In the current situation, shopping for food should be possible on the web. Be that as it may, monitoring some food supplies is the principal work of the individual dealing with kitchen, bombing which will bring about deficient things to cook. The framework expressed in this paper removes this duty from the individual taking care of kitchen. The goal of this paper is to propose a framework which will follow the accessibility of staple goods in the kitchen. The test information is considered by the everyday use of a grain in the kitchen. Monitoring the kitchen stock prompts more educated arranging and dynamic. With innovation progressing in a high speed and everything around us getting robotized, individuals like to screen and play out their everyday exercises by utilizing the keen gadgets they convey wherever instead of physically recording and observing things. Keeping up and monitoring ordinary basic food stock is getting one of the serious issues in different families, cafés and natural pecking orders. Recharging the holders at the right second and furthermore knowing the expiry of food sources is a significant concern. Working individuals and occupied cafés think that it's hard to keep track since it requires human mediation at the opportune time.

Index Terms - Kitchen inventory techniques, Inventory management, Oraganize inventory, Internet of things.

I. INTRODUCTION

IOT has changed life of humans. Each thing is uniquely identifiable through its embedded computing system within the internet infrastructure. Taking advantage of IOT function we develop a project on smart Kitchen Management using Sensing the weight of a kitchen storage container. Your pantry will reflect your cooking style. Organize your pantry according to types of foods so that you can find things. Grains: Rice, pasta, oatmeal, etc. Root vegetables: onions and potatoes, and the like can go in your pantry. And we can find out the actual storage and remaining item quantity for a specific time period and notify. In order to produce the desired strain for determining the container's weight, the load cell needs to be mounted between two flat surfaces with the help of the two threaded holes on each side of it. Once mounted, the flat surface can act as a scale for measuring the weight of a storage container on our mobile application and Track food consumption.

We can also work on Generating list of items of remaining item quantity. profitable for more educated arranging, dynamic and extravagance of people.

Consistently the modem individuals anticipate that new gadget and new innovation should streamline their everyday life. The pioneers and looks like are continually attempting to discover new things to fulfill the individuals utilizing advancements however the cycle is as yet endless. Presently a day, kitchen robotization got current and exact to screen the fields. During the 2000s, Internet network turned into the kind for some applications and today is normal as a component of numerous ventures, modern and customer items to give admittance to data. Be that as it may, these gadgets are still essentially things on the communication and observing through applications and interfaces. With the progressions in Web advances, and remote sensor organization (WSN), another pattern in the period of universality is being figured it out. Colossal expansion in clients of web and alteration on the web working innovations empower systems administration of regular items. Akshay Pendbhaje et al. proposed the IoT in Home Grocery Management System. They utilized the heap cell to gauge the basic food item weight, Raspberry Pi microcontroller board which employments MQTT protocol. The objective of this paper is to propose a system which will track the availability of groceries in the kitchen [1]. Hardi Desai et al proposed IOT based fundamental need noticing structure to screen the staple measurements at homes and market. Here weight sensors and far-off transmission module related with a central center point. The central center is accountable for dealing with the data got from the pile sensors. By moving this data into online data stream, it will in general be used for additional assessment. Taking into account the got data, fundamental stock level in each house is assessed. Nerella Ome et al. proposed an IoT based sensors to cloud framework utilizing ESP8266 and Arduino Due. In this framework sensors like temperature sensor and dampness sensor are utilized to detect data the gadget and converts it to computerized utilizing Arduino board. Arjoo Pathan et al proposed a framework Smart Super market structure for Shopping Mall. This uses RFID readers and IoT. This makes shrewd crates in which the RFID resders are joined. This will demonstrate the all-out Bill measure of the products which is in the bushel by perusing all the RFID Tags appended to each great. These RFID peruses are joined to the top edges of the container or the streetcar. Likewise, it will show the heaviness of the crate and the quantity of things dropped into it alongside complete expense. Santosh H. Kalange et al proposed Smart Retailing using IoT. This structure uses RFID follower, RFID Tags, Lad cell, HX711 weight sensor, Wi-Fi module, Arduino Uno board. The principal pointed of undertaking is using IoT development tackle the certifiable issue face by retailer and customer using the android App. In proposed structure retailers understands that number of things stays in market.

II. CONSUMER AND ENTERPRISE IOT APPLICATIONS

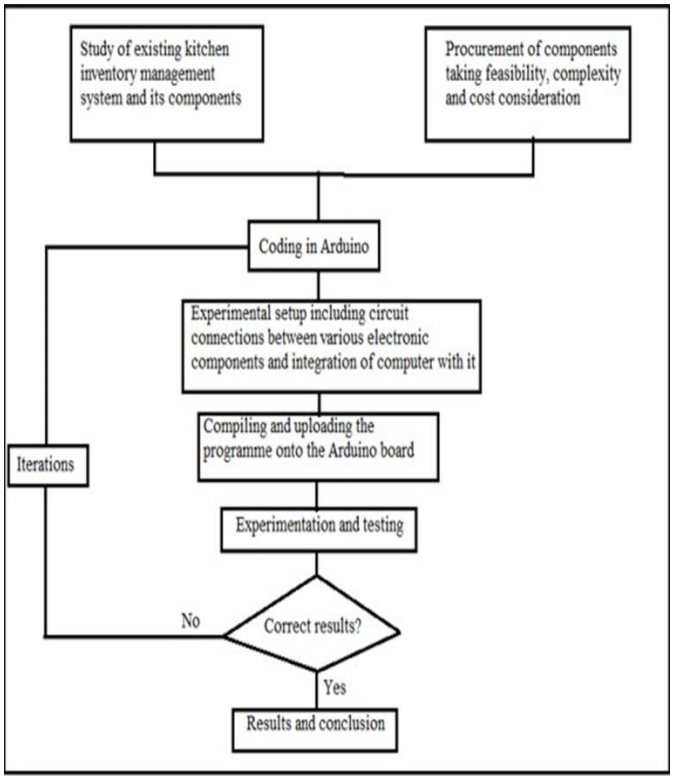
There are various genuine uses of the web of things, going from purchaser IoT and venture IoT to assembling and mechanical IoT. IoT applications range various verticals, including car, telco, energy and that's only the tip of the iceberg. In medical services, IoT offers numerous advantages, including the capacity to screen patients all the more near utilize the information that is produced and examinations it. Emergency clinics frequently use IoT frameworks to finish assignments, for example, stock administration, for the two drugs and clinical instruments. Savvy structures can, for example, lessen energy costs utilizing sensors that recognize the number of tenants is in a room. The temperature can change consequently for instance, turning the climate control system on if sensors distinguish a gathering room is full or turning the warmth down if everybody in the workplace has returned home. In agribusiness, IoT-based shrewd cultivating frameworks can help

screen, for case, light, temperature, dampness and soil dampness of yield fields utilizing associated sensors. IoT is additionally instrumental in robotizing water system frameworks. In a savvy city, IoT sensors and organizations, for example, keen streetlamps and shrewd meters, can help mitigate traffic, preserve energy, screen and address ecological concerns, and improve sterilization.

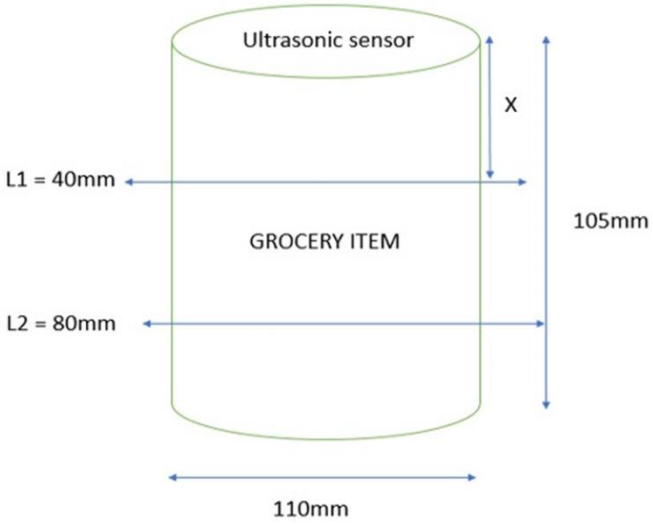
III. OBJECTIVES OF STUDY

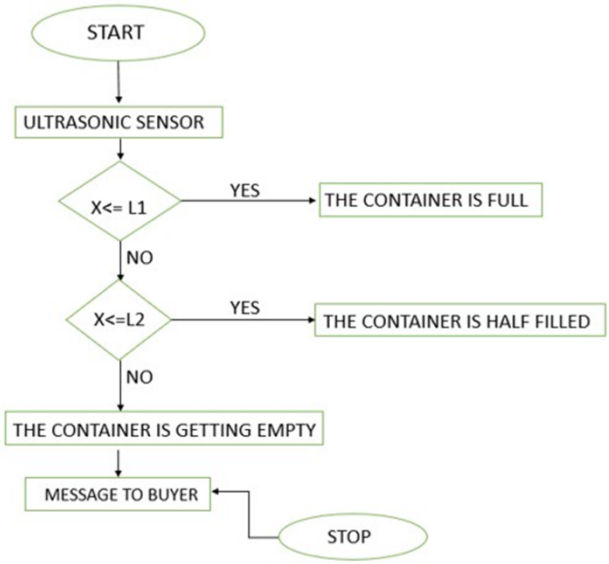
1. The proposed system helps to smartly handle the grocery management at home so that to avoid situations like forgetting to buy grocery at emergency.
2. It is made to help the working woman to manage grocery backups.
3. It is made to help geriatric people so that they get rid of going to shopping regularly.

IV. METHODOLOGY



V. FLOWCHART

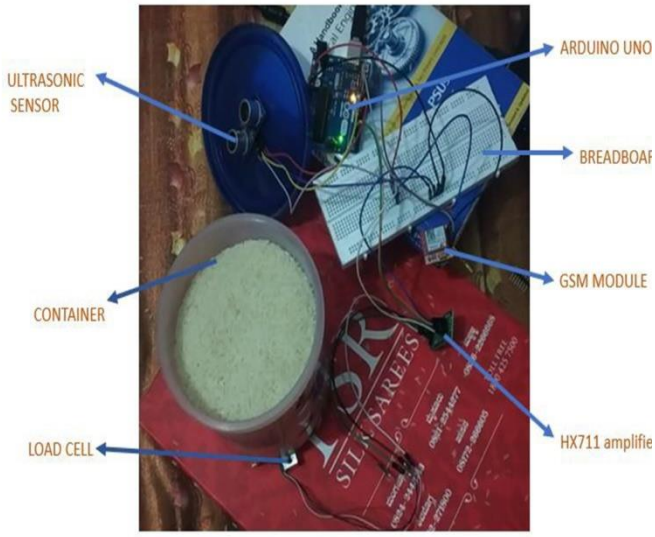




The setup includes components as discussed such as Arduino board, Breadboard, Ultrasonic sensor, Load cell, HX711 amplifier, GSM module, Male to Male, Female to Female and Male to Female jumper cables. The initial connections are made as per the circuit diagram (Refer Fig). Program (C++ language) for working model is uploaded to Arduino board. A container is chosen for filling the grocery item. Working model has been divided into three zones as shown above. X is the distance measured by the ultrasonic sensor from the cap of the container. Load cell is kept at the bottom of container to calculate the

weight of the grocery item. HX711 amplifier is used to amplify signal from millivolts of load cell to volts(v). GSM module is used to send the signal to the buyer when the grocery item is getting empty.

VI. WORKING SETUP



VII. RESULTS AND DISCUSSIONS

```
-> Distance : 4 cm
-> The container is full
-> Press T to tare
-> 17.66
-> Weight:
```

The result shows that the grocery item is at a distance of 4cm from the cap of the container. It shows that the container is full and weight is 17.66 units.

```
18:38:03.075 -> Distance : 7 cm
18:38:04.059 -> The container is half
18:38:04.106 -> Press T to tare
18:38:03.075 -> 13.01
18:38:03.075 -> Weight:
```

The result shows that the container is half filled and the weight of grocery item is 13.01units.

```
18:42:16.199 -> Distance : 9 cm
18:42:20.230 ->  Container is getting empty
18:42:20.277 -> Press T to tare
18:42:24.558 -> 9.15
18:42:24.558 -> Weight:
```

The result shows that container is getting empty and weight of grocery item is 9.15 units.

After this the GSM module sends a message to the buyer that container is getting empty and sends the weight of the grocery item.

The circuit is prepared and tested. It showed good results with 86 milliseconds and the delay time of the sensor is 1 sec. The range of the sensor is up to 6 meters and there is a signal for every change of quantity of grocery in the container. Due to high sensitivity of sensor, there was fault in distance accuracy to divide the zones. This can be reduced by manually reducing the sensitivity of the sensor and increasing its delay time between each signal output. The overall cost of the model came out to be around 3000rs.

Excitation voltage (input voltage) = 5V
Range of measuring voltage by load cell = 250mV
Load cell sensitivity, (mV/V) = Range of measuring voltage / Excitation voltage
= 250/5 = 50mV/V
In the 1st Zone:
Observed reading = 17.66mV
= 17.66/1000 = 0.01766V
Full scale reading by load cell = 10kg Observed reading = 0.01766*10 = 0.1766 V-kg
Output reading in terms of Kg = 0.1766 / (250/1000)
= 0.706kg
= 706grams Similarly, for 2nd Zone and 3rd Zone are 522grams and 366grams.

VIII. CONCLUSION

Ultrasonic sensor checks the quantity level and sends the output to Arduino board. Gsm module sends SMS to the respective grocery buyer. Although the system may not be able to provide advanced solution to the kitchen inventory, it provides a detecting item in a small scale. Amplifier is used to amplify load cell signals to send it to Arduino board. This system is connected with online grocery shop, as a result user will easily buy their goods before running low through their mobile device.

In future it can be designed the system in a way by replacing separate Arduino with a microcontroller on the chip. This reduces the size and cost of the system while improving its functionalities. The system can also be integrated with food industries, Restaurants, etc, to manage the grocery backups.

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National Conference on Recent Advances in Mechanical Engineering and Materials
International Journal of Scientific Research in Mechanical and Materials Engineering
2021 IJSRMME | Volume 4, Issue 7 | ISSN : 2457-0435

Hardness and Wear Characteristics of Al2214/Silicon Carbide reinforced Aluminium Metal Matrix Composites

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ABSTRACT

The latest in material improve very high achievement in innovations. Advancement of Composite materials is noteworthy advance in streamlining the materials. The MMC'S is reinforced with SiC particles, stated as Al MMC's, it have more developments in their physical and mechanical properties as compared to conventional MMC's. The proposed work is to fabricate and compare the mechanical and physical properties of Al2214/SiC composites. The composites were readied utilizing mix projecting strategy in which measure of Silicon Carbide, is differed independently from 2-10 wt% in strides of 2wt%. The mechanical properties of created composite MMC's are assessed and contrasted and unadulterated compound.

Keywords- Silicon Carbide, AL2214, MMCs, Hardness, Wear

I. INTRODUCTION

Aluminium Alloy 2214 material is used in industrial needs and their applications are in automobile sectors like pistons, piston heads, and bearings, where the friction and wear rate is more important role due to having high wt% copper.

The general criteria to choose this series are:

- High mechanical resistance.
- High resistance to fissure propagation .
- Improves its tenacity.
- Poor corrosion resistance.

The AL 2214 based alloy have physical properties:

- Tension Strength >=425
- Yield Strength >=275
- Hardness 125-145

Table 1: Aluminium alloy 2214 Chemical composition

Weight %	Al	Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti
Al2214	Balance	1.2	0.3	5.0	1.2	0.8	0.1	0.25	0.15

"Fig. 1"Al2214 Ingots

The Al2214 is a hardest aluminum alloy which having manganese, the two parameters like silicon and copper as its major alloying elements. Mechanical properties which enhances the heat treatable alloy as compared to other Aluminum alloys. And it increases high strength, good achievable workability, maintain good machinability and increases resistance to corrosion.

The Silicon Carbide (SiC) particles are in powder form of size 45-50 μm and it is used as reinforcement in this experimental evaluation, and their mechanical properties of Silicon Carbide are shown in table 2.

"Fig.2" Silicon Carbide Particulates

Table 2: Mechanical properties of Silicon Carbide

Mechanical Properties	Silicon Carbide (SiC)
Density	3.02 gm/cc
Molecular weight	40.20692 g/mol
Melting Point	1380°C
Vickers Hardness	2800
Crystal structure	Hexagonal crystal structure
Thermal Conductivity	120 W/m.K

Silicon Carbide is an inorganic metal oxide which is mainly used in ceramic materials. Silicon Carbide succeeds tungsten as the compound that most frequently occur in nature

The Silicon Carbide is an inorganic metal oxide, which is mainly used in ceramic materials.

The single support Al lattice may some of the time bargain the estimations of its physical and mechanical properties. Subsequently, it is fundamental to recognize approaches to hold the worthwhile impact of SiC while at the same time taking care of the issues of machining SiC-fortified composites.

Improving the growth in base metal the reinforcement of ceramic particles that are found in fibers, whiskers and particulates and is mixed by using stir casting method to achieve required properties of metal matrix composites.

The Al2214 combination was utilized as network compound and SIC was utilized as fortifications for arrangement of composites. SiC of 2-10 wt. % (span size 2%) the worth is fortified with the Al2214/SiC composites.

The pot containing with the hardened steel impeller was covered with alumina. The charge of about 3kg was liquefied under unadulterated magnesium of high virtue. The Degasser used to make latent environment to evade oxidation and eliminates the slag from the Al2214 slurry.

The impeller speed was kept up at range between 400-600 rpm. During blending, the preheated SiC was poured in to the liquid metal for blending consistently. Whenever mixing was finished, the heater was inclined and dissolve was filled the cast-iron kick the bucket.

Table 3: Composition of specimens Reinforced

Specimen	Al2214 (gm)	SiC (gm)	Wt.%
A	2000	0	0
B	1960	40	2
C	1920	80	4
D	1880	120	6
E	1840	160	8
F	1800	200	10

Stirring procedure as shown in Figure.3 it shows that the temperature-time bend demonstrating the direction and the temperature trips utilized in these trials. .

There are different periods of the handling plan.

Stage 1 : Maintained liquid metal in heater for 60 min in inactive air condition.

Stage 2 : The liquid metal got to the working temperature up to 7000C.

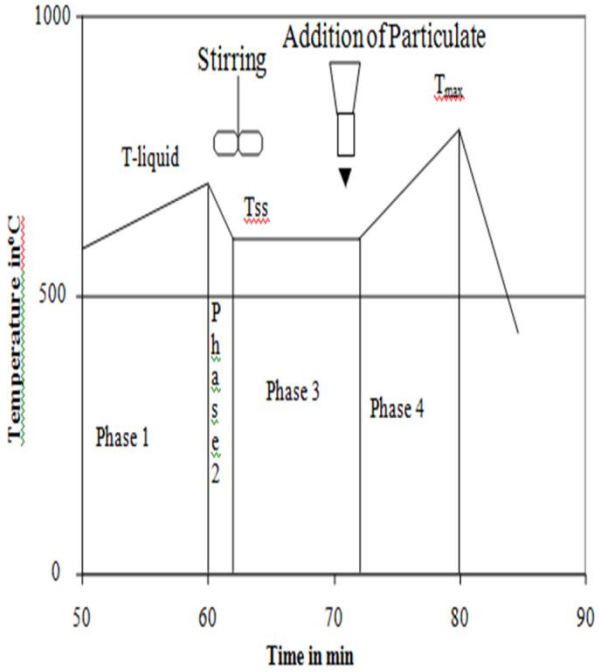
Stage 3 : The fortification stage is brought into the liquid (slurry) in the semi strong stage for 5 min appeared in Fig.3.

Stage 4 : From the temperature time twist, the composites were re-mellowed to a temperature over the liquidus temperature (Tmax = 700-7200C). For 10 min of length.

Table 4:Stirring Parameter

Stirring Temperature	Stirring Speed	Stirring time
700C	500 rpm	600 Seconds

Stage 5 : Stage 5: The liquid metal Poured into the shape cavity and permit to cool in room temperature for 15



"Fig 3" Schematic representation of the temperature-time sequence for Composite preparation

To develop the taking care of huge scope and microstructure relationship the planning conditions are as demonstrated in Table 3.

II. CHARACTERIZATION OF AL 2214 SIC MMC'S BRINELL HARDNESS TEST (ASTM E10)

ASTM E10 technique covers the assurance of the Brinell hardness of metallic materials by the Brinell space hardness standard.

In our work we have conducted hardness test by using Rockwell and Brinell hardness testing machine in accordance with ASTM E10 standard.

- Place the example on the iron block so its surface will be ordinary to the bearing of the applied burden.
- Note the sort and size of the indenter
- Adjust the loads on the unclogger as indicated by the sort of test whether it is Rockwell or Brinell appeared in diagrams by load determination circle keep the switch at position "A"

- Raise the iron block and test example by turning the hand wheel clockwise with the goal that example will push the indenter and the little pointer in the dial begins to move
- Continue to raise the example until the little pointer comes to SET (red spot) position.
- This shows that the minor heap of 10 kgf is following up on the example Turn the switch from position "A" to "B" gradually so the all out burden is gotten to activity with no bastards.
- The indenter begins to go down into the example and the long pointer of the dial measure arrives at a consistent position when spaces total
- Take back the switch to position "A" gradually
- Read the situation of the pointer on the chose scale. Which gives the number according to the chose kind of test Turn back the hand haggle the example
- Carry out similar methodology to acquire three free hardness judgments on every example.

Wear Test (ASTM G99)

To contemplate the wear of materials, on various examples with a similar test conditions. One approach to play out the wear test is with a ball or pin on circle Tribometer (ASTM G99). With this test, a reference test is mounted on a pivoting stage and a pin or ball (object of study) interacts with the example surface with a known applied burden. A ball or pin for the assessment of wear misfortune gives a few particular focal points.

Assessing the wear of the ball or pin gives wear data at the contact point which stays under burden during the full term of the test. This contrasted with the base material that solitary encounters wear during a similarly brief timeframe.

The wear models are attempted under dry status, by use of pin-on-disc is used to determine the wear characteristics. The regular procedures are taken considered to evaluate the wear, are loss of mass in the material, expulsion methodology, insufficiency of weight strategy and wet wear test. The model is weighed from the outset and make a note of weight keeping the sliding distance as in steady state; the sliding squeezing factor can vary by increasing loads and coordinating test. At last weight to be recorded. The gadget includes a turning plate of broadness 200 mm. Strategies are used to hold and load on the models.

The models were cut immovably the model hold against turning steel circle. The models were cleaned through and through and weighed unequivocally using an incredibly trustworthy and a tricky harmony to a precision by three decimals. The surfaces of the work models were seen using a looking at electron amplifying instrument.

As wear properties of the steel plate are not considered for examination because disc wear volume was very small. The cylinder wear test instances of width and length of 10 mm and 50 mm were cut, ground and cleaned to the essential size preceding testing. The wear tests were finished pin-on-disc wear testing machine according to ASTM G99 rules. The test tests were supported in the holder and held against the rotating wheel far off of 60 mm from the Center. In the current assessment, customary loads of 15N, 30N, 45N, 60N and 75N independently were applied on the model and the speed of the turning wheel are changed from 200 to 500 rpm in steps of 100 rpm.

A framework is used for test model:

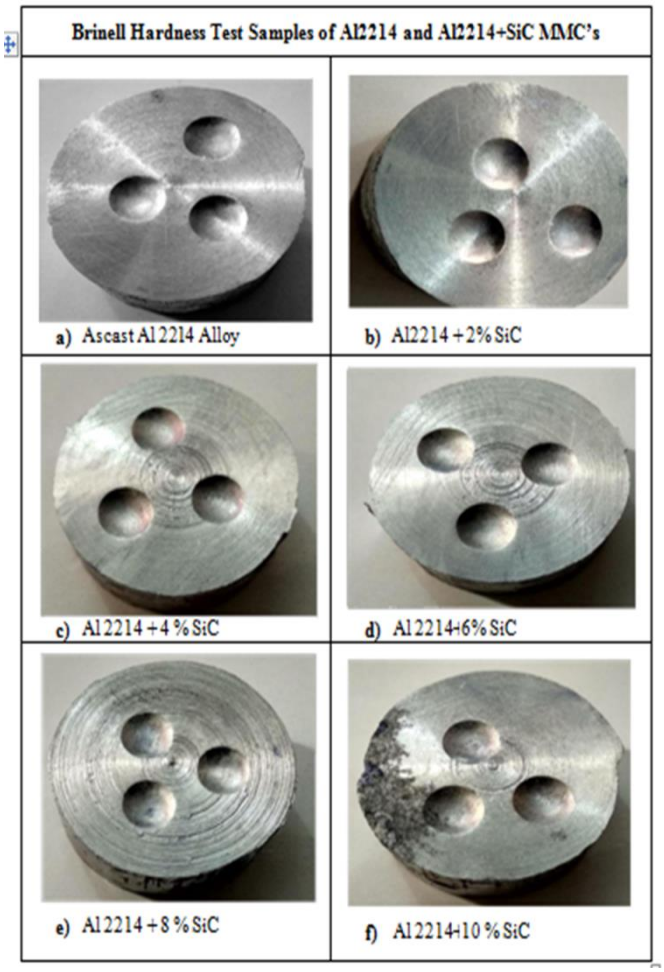
- The size of 10 mm width and 50 mm length was balanced by electronic balance to a precision level of 0.01 mg to choose the fundamental weight.
- The illustration of size 10 mm expansiveness and 50 mm length was first said something an electronic harmony to an accuracy level of 0.01 mg to choose the basic weight.
- The models fixed in wear testing machine for different loads and rates for 15 minutes.
- The models were reverified after the tests for decrease in weight .

III. RESULTS AND DISCUSSION

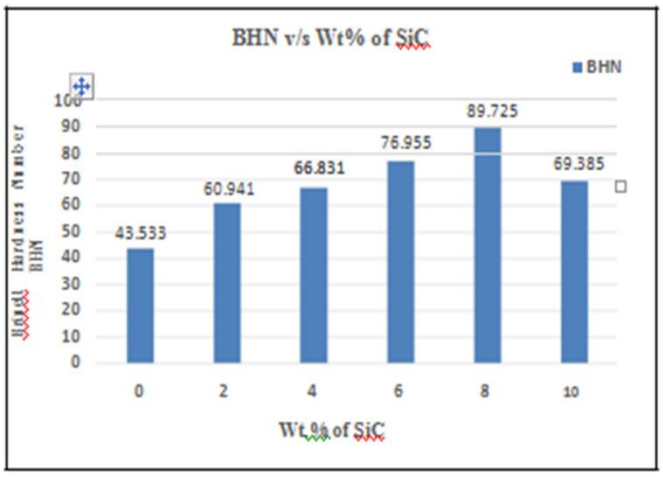
Brinell Hardness Number

Table 5: Brinell hardness number (BHN) for Al2214 and Al2214/ SiC Metal Matrix Composites.

Sl No	% of Reinforcement	BHN
1	Al 2214	43.533
2	Al2214 + 2% SiC	60.941
3	Al 2214+ 4% SiC	66.831
4	Al 2214 + 6% SiC	76.955
5	Al 2214 + 8% SiC	89.725
6	Al 2214+10% SiC	69.385



"Fig. 4" Brinell Hardness Test Specimens Test Specimens of a) Ascast Al 2214 Alloy,b)Al2214 + 2% SiC, c) Al 2214 +4 % SiC, d) Al 2214 + 6% SiC,e)Al 2214 + 8 % SiC, f) Al 2214 + 10 % SiC



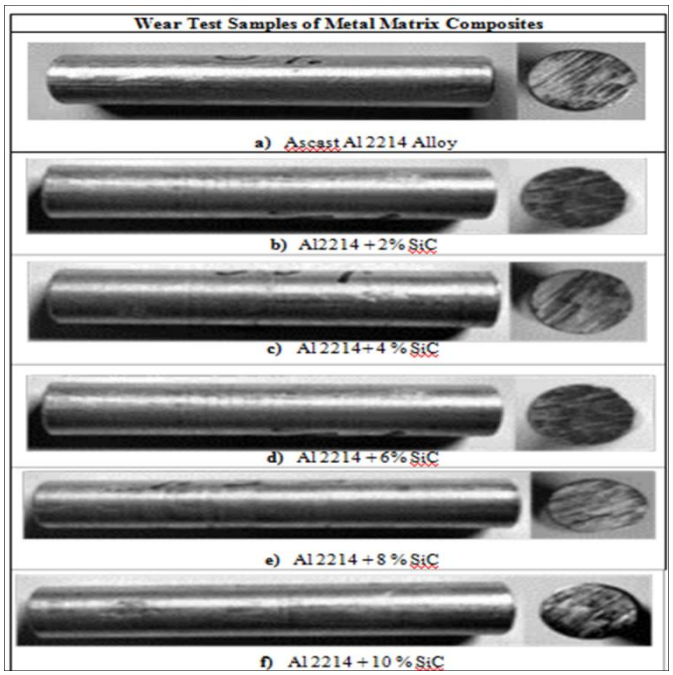
"Fig.5" The effect of Wt.% SiC on Hardness of Al 2214and Al2214/SiC composites

The Table 5 presents the normal of three hardness (BHN) perusing estimations of combination and its composites. Figure 5. shows the charts for the impact of support content on brinell hardness number of the prepared Al 2214 amalgam and Al 2214 + (2 - 10 wt.% of Silicon Carbide) composites. Each estimation of hardness is a normal of 3 readings (tests).

From the graphs is seen that increases in hardness was refined up to 8 wt.% SiC. As increasing in SiC from 0 to 8 wt.% the hardness extended by about 51.48 %. The augmentation in hardness can be credited the content of Silicon Carbide offer fortitude the organization mix, thusly giving improved insurance from space or scratch.

From the diagram it is seen that there is an abrupt diminishing in hardness of the composite at 10 wt.% of Silicon Carbide support, which is supposed to be diminished by 22.6 %, its because of the groups development and primarily in view of disengagement and de-holding between the framework and fortification.

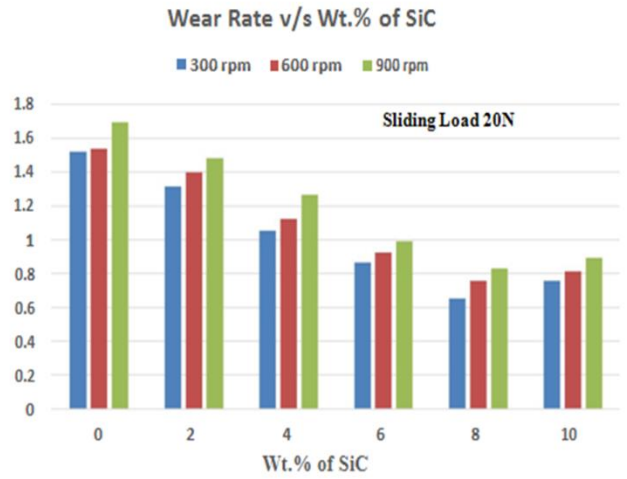
WEAR TEST



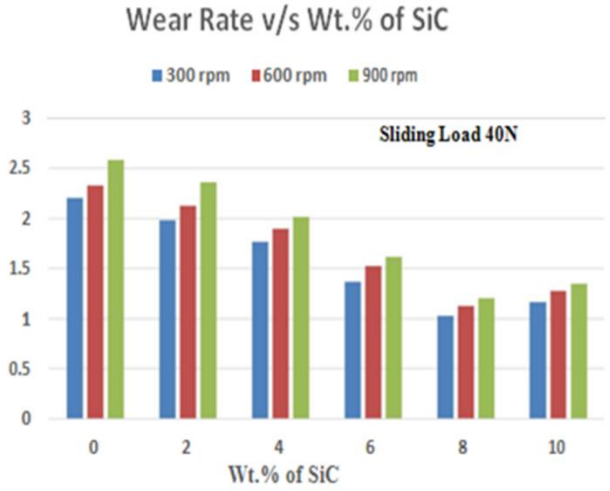
"Fig. 6" Wear Test Specimens of a) Ascast Al 2214 Alloy, b) Al2214 + 2% SiC,c) Al 2214 +4 % SiC, d) Al 2214 + 6% SiC, e) Al 2214 + 8 % SiC,f)Al 2214 + 10 % SiC

Table 6: Wear rate (mm3/m) of Al/ SiC MMCs of different Loads and speed Condition

Load N	Sliding Speed RPM	Wear Rate in 10^{-3} mm³/m					
		Wt.% of SiC					
		0	2	4	6	8	10
20	300	1.5189	1.312	1.0526	0.865	0.652	0.756
	600	1.538	1.397	1.1206	0.923	0.756	0.812
	900	1.6919	1.482	1.2639	0.989	0.827	0.891
40	300	2.198	1.982	1.762	1.368	1.026	1.159
	600	2.326	2.125	1.892	1.521	1.123	1.276
	900	2.581	2.361	2.012	1.612	1.198	1.345



"Fig. 7" Effect of wt. % of SiC and sliding speed on wear behavior of the Al 2214/SiC composites at 20N



"Fig. 8" Effect of wt. % of SiC and sliding speed on wear behavior of the A2214/SiC composites at 40N

Keeping other conditions same, Al 2214 shifting level of Silicon Carbide particulate scattered in various ways were evaluated for wear obstruction contrasted with the base network without scattering. From Table 6 as shown that the cast models were furthermore included the testing of wear rate in terms decrease in weight in a composites of 0, 2, 4, 6, 8 and 10 wt.% of Silicon Carbide independently ascast.

Information recorded on wear speed of Al2214/SiC fortified MMC's at various loads of 20N and 40N, various paces of 300, 600 and 900 rpm at various Wt.%

of Silicon Carbide added to the Al Alloy as fortification is introduced in table 6. The wt.% of Silicon Carbide added to the Al Alloy helps the wear speed of the composite material and decreases expanding of load and sliding rate up to 8 wt.% of Silicon Carbide (SiC). Nevertheless, there is expansion in the wear rate for 10 wt% of Silicon Carbide.

The impact of Silicon Carbide (SiC) content on wear attributes of Al 2214/SiC particulate for the wear test of rotational speed of 300, 600 and 900 rpm and loads of 20, and 40N is appeared in Figs 7 and 8 which are the specialist charts plotted subject to wear rate results.

Coming up next to uncovered the assessment of wear speed of Al 2214/SiC composites rely on the % of Silicon Carbide (SiC) scattering. Wear rate was found to reduce with the expansion in SiC content from 2 to 8 wt. %. There is an inevitable result for expansion in wear rate for the 10 wt.% of Silicon Carbide (SiC), when separated and the 8 wt.% maintain.

The weight rate is least for the composite containing 8 wt.% SiC .The wear rate remains constant at lower loads.

Wear rate was occurred at Al2214 yet dependably this diminished. Maybe, by virtue of hard particles of SiC scattered in the base association there is all around speedy accomplishment of steady quality in the wear opposition, as seen.

IV. CONCLUSION

It is seen that the hardness is drastically increased at 8 wt.% SiC. As the Silicon Carbide from 0 to 8 wt. % the hardness of the material is increased about 51.48 %. The presence of Silicon Carbide particulates will improve the hardness that present fortitude to the matrix blend, in this way giving improved insurance from space or scratch.

From the diagram it is seen that there is an abrupt diminishing in hardness of the composite at 10 wt.% of Silicon Carbide fortification, which is supposed to be diminished by 22.6 %, its because of the bunches development and essentially due to separation and de-holding between the lattice and support.

The weight rate by wear is least at 8 wt.% of composite. The SiC dispersoid is main role. The wear rate remains less at lower loads by increase in rpm.Also, light wear rate ar show up at Al2214 without dispersoid anyway reliably adversity reduced. As a result of hard particles of Silicon Carbide (SiC) dispersed in the base organization there tolerably fast accomplishment of solidarity in the wear resistance, as seen.

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National Conference on Recent Advances in Mechanical Engineering and Materials
International Journal of Scientific Research in Mechanical and Materials Engineering
2021 IJSRMME | Volume 4, Issue 7 | ISSN : 2457-0435

The Strength and Stiffness of Aluminium Alloy LM12/ SiC (23 Microns) Metal Matrix Composites and Comparison of Brinell Hardness Test Experimental Results With Axi Symmetricfeanalysis

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ABSTRACT

The aluminum alloy is produces the excellent and superior properties, these alloys are widely uses in different industrial sectors like, agriculture, constructions, aerospace, automobile, utensils, and general engineering industries, due to this alloys are very favorable in microstructure behavior, hardness, less weight ratio, high strength and having good mechanical properties. In this work the aluminum alloy LM12 is the base material reinforced with the silicon carbide. These metal matrix composites are fabricated by using the stir casting techniques with the uniform distribution of SiC and confirmed by using the BHN test, SEM,XRD and EDX analysis. The MMC's evaluate the mechanical properties such as Brinell hardness number experiment test results are comparison with the BHN Finite element analysis. The FEA model has been prepared by using the ABQUS software evaluate the maximum stress, deformation and load carrying capacity. The MMC's obtained results are compared with the pure AALM12 alloy without of silicon carbide addition. The reinforced silicon carbide varies with the 0%, 5%, 10%, 15% &20%wt.fraction. Increment of SiC in MMC's, the Brinell hardness number values also be increases due to matrix is became good in strength and strong, these are the properties are presented in this paper.

Keywords : 23μmSiC, AALM12, MMC'sFabrication, Brinell hardness number experiment test results comparison with FEA, SEM, EDX and XRD analysis of MMC's.

I. INTRODUCTION

Aluminum alloy metal matrix composites are very popular aluminum alloy many series used in different industrial sectors. These are mainly used in aircraft structure design one of the major criteria due to their high strength ratio and less in weight ratio. Due to this mandate in high recital of the aircrafts weight reduction methods are used in aviation sector and new materials are under search in automobile sectors used. (1-3). The aluminum alloys reinforced with silicon carbide (MMC's) having possess superior symbols in order to decrease the weight and consequently proved to be improved structural

components to provide strength to the structure. Enormous research work has been experiencing in the area of MMC's. Because of their weight to strength ratio, MMC's are gradually replacing the popular aluminum .alloys which were used post world war in Aircraft and in other

Applications like agriculture, automobile sectors and construction fields etc. (4-6).

Current work is describes the production of MMC's by using the popular technology of stir casting technique, tensile test experimented results as well as FEA results are analysis, density test and porosity. Aluminum alloy LM12 with reinforcement of silicon carbide with various %wt and compositions of AALM12 has been shown in below fig.

Element	Wt.%	Element	Wt%
Copper	09-11	Zinc	0.8 max
Magnesium	0.2-0.4	Lead	0.1 max
Silicon	2.5 max	Tin	0.05 max
Iron	1.0 max	Titanium	0.2 max
Manganese	0.6 max	aluminum	Balance
Nickel	0.5 max		

Compositions of AALM12

II. DEVELOPMENTOF METAL MATRIX COMPOSITES

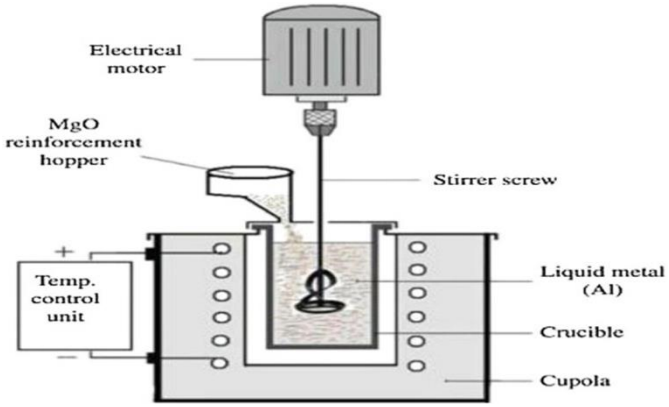
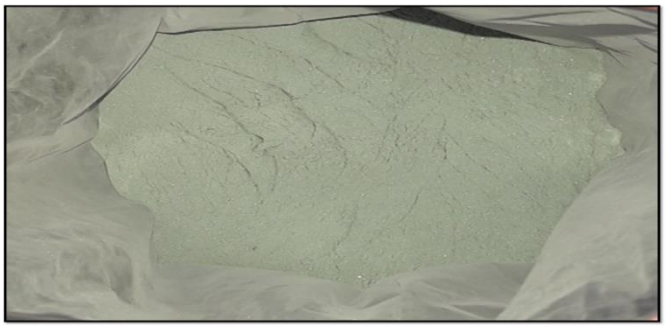


Fig:1 Stir casting set up

The MMC's are fabricated by using the popular stir casting technique, this setup have been shown in the fig:1. The AALM12 aluminum alloy bars were kept inside the crucible furnace which is made up of graphite material and the heating source is supplied by the electrically. The aluminum alloy is slowly turn into molten stages when it is exceeded the temperature of 6500C -7500C.Their after calculated weight percentage of SiC slowly pour into the molten metal with uniform speed, meanwhile maintain the stirrer speed in uniformly ranges from 300rpm-400rpm and this is operated by supporting of electrical motor and Also different wt%SiC composites are fabricated with followed same procedure.

AA7075 bar



23 micorns SiC

Fig:2 Cast product and SiC

III. EXPERIMENTATION

Hardness test is essential to measures the resistance of the material to lasting shape change when a force is applied. In this work, Brinnal hardness test is used to carry out the deformation (hardness) of the fabricated composite. The test is carry through as per the standard ASTM: E10. In this test, 250kg load is load is applied for a period of 20 seconds. The test result has been expressed in the format of number called brinell hardness number.

BHN test Samples

Table:1 Specifications

Model	KAB-1
Max test height	225mm
Depth of thread	130mm
Max depth of screw below base	260mm
Max Load	250kgf

Ball material	BHN
Specimen material	Al alloy LM12
Specimen Dimensions (mm)	12
Ball diameter (mm)	5
Load (kgf)	250
Testing time (sec)	20

$$\frac{F}{\frac{\pi}{2} D \left(D - \sqrt{D^2 - D_1^2} \right)}$$

Experiment BHN Results

Compositions	Depression dia D_1 in mm	Trail 1	Trail2	Trail3	Avg.BHN
Pure	2.5	47	46	49.5	47.5
5% SiC	2.3	54.5	59	57	56.8
10% SiC	2.2	62.5	60	64.8	62.4
15% SiC	2.1	67.5	70	69	68.8
20% SiC	1.9	84	85.5	85	84.8

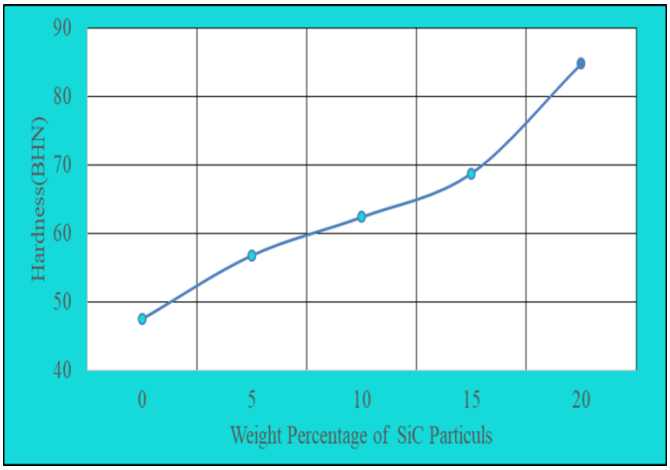


Fig:3 BHN Results

Hardness analysis of as-cast composite confirmed (84.8 kgf/mm2) superior hardness values without

addition of filler material composite than as-cast composite (84.8 kgf/mm2) that shown in fig:3.This improved results are indicated to better tensile characteristics of composites. Comparative analysis confirmed improvement in ultimate strength and decrease in percentage elongation for the composite. Fractographic analysis of as-cast composite reveals Trans granular failure of composites [3]. As observed from the hardness value increases up to 20% weight fraction of SiC and beyond this weight fraction the hardness trend started decreasing. In the hardness test, severe plastic flow has been concentrated in the localized region directly below the indentation, outside of which material still behaves elastically. Directly below the indentation the density of the particles increased locally, compared to regions away from the depression. The results of the Brinell hardness measurements are shown in figure. It increases with increasing wt% of the particulates used in this work. These increases can be related as mentioned before to the interaction of the dislocations with the particulates and grain refinement with increasing wt%of SiC[5].

IV. FE ANALYSIS OF BHN

$$BHN = \frac{F}{\frac{\pi}{2}D\left(D-\sqrt{D^2-D_1^2}\right)} \quad \text{Kg/mm}^2$$

Where
F= load Applied kg f
D= Steel ball diameter of in mm
D1= Depression diameter in mm

In hardness test, first of all samples of 20mm diameter and 15mm length in cylindrical round bar were developed from manufacturing process. The specimens were fabricated by filing for making perfectly parallel Brinell before hardness testing. Samples were polished by using different types of emery papers and tests were carried out by using Brinell hardness tester with load of 250kg at room temperature condition.

Young's modulus of MMC's is given by Kerner equation

$$\mathbf{E_c = E_m\left[1+\frac{V_p}{1-V_p}\times\frac{15(1-m_m)}{8-10m_m}\right]}$$

Where Em is Youngs modulus
of the Matrix i.e 71 GPa
V_p is the volume fraction of particulate
M_m = poisons ratio

$$\mathbf{E_{c5\%SiC} = 71\left[1+\frac{0.04606}{1-0.04606}\times\frac{15(1-0.33)}{8-10(0.33)}\right] = 78.199\ GPa}$$

The calculated the young's modulus of metal matrix composites by using the karner question, the results shows that linearly increased with increased reinforced SiC.

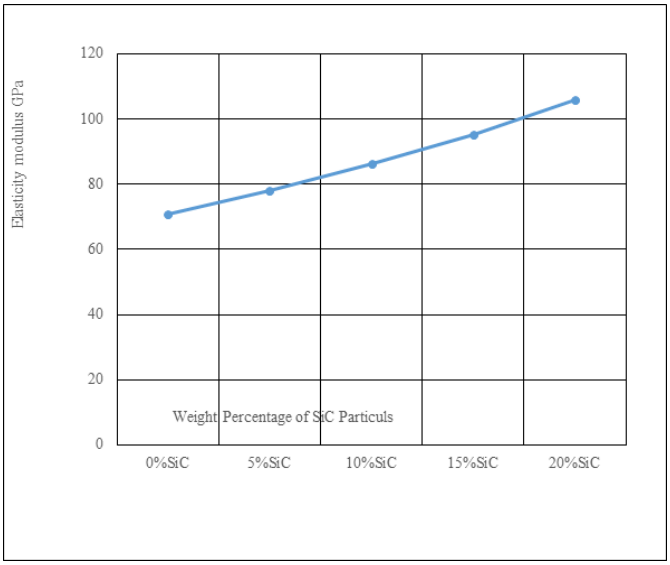


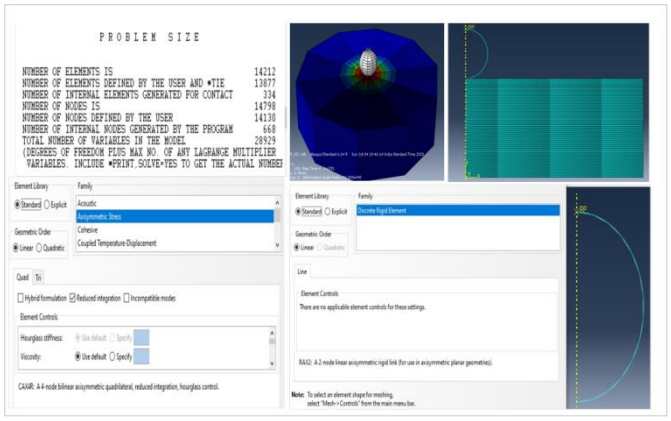
Fig:4 Elasticity modulus

Table:2 Properties

Compositions	E using Karner Eqn.	Experiment Yield strength MPa
Pure	71	68
5%SiC	78.199	78
10%SiC	86.312	79
15%SiC	95.426	93
20%SiC	105.766	74.5

The Elasticity modulus of metal matrix composites linearly increases with increased SiC as shown in fig:4. The youngs modulus and Yield strength values are feed into FE analysis and to get the BHN results in FEA.

Procedure have been followed to do the FE Analysis of BHN



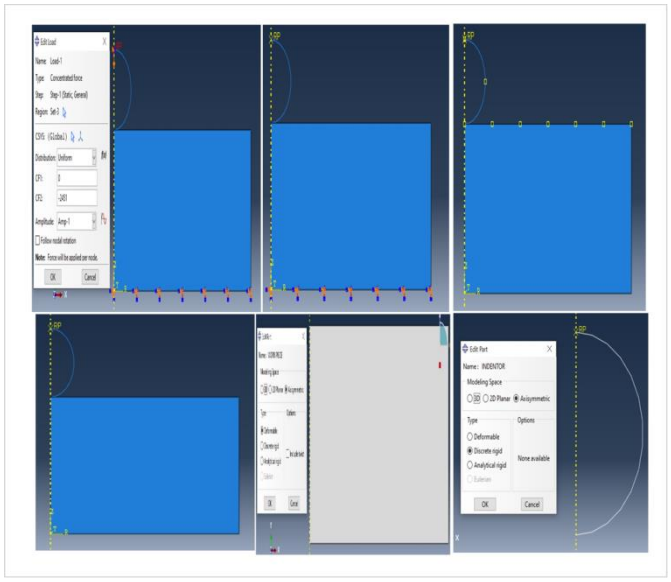
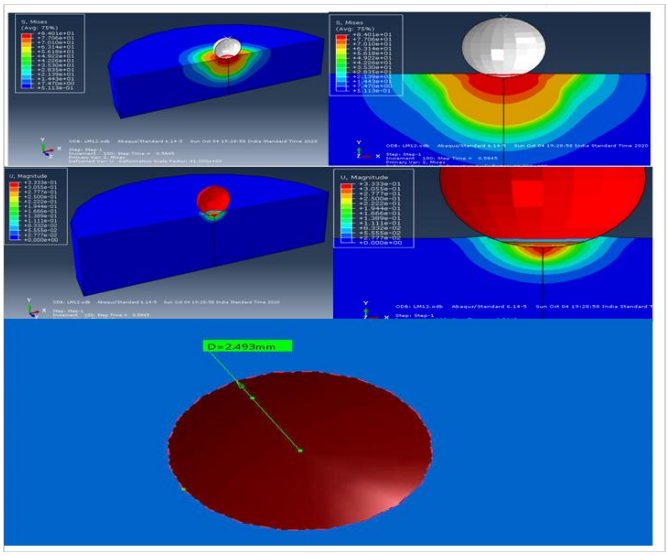
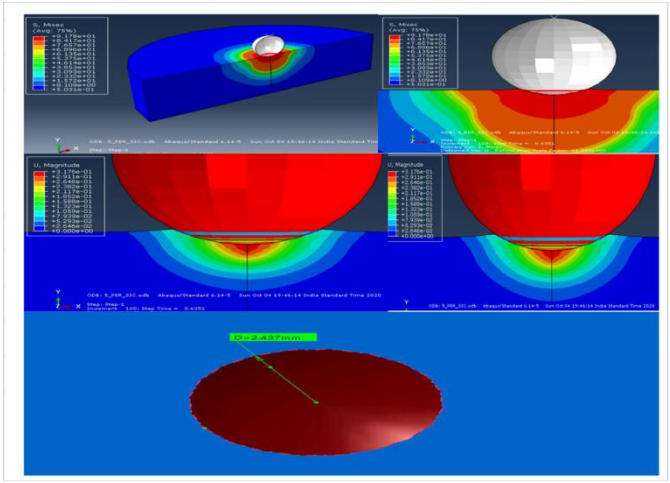


Fig:5 BHN FEA Model

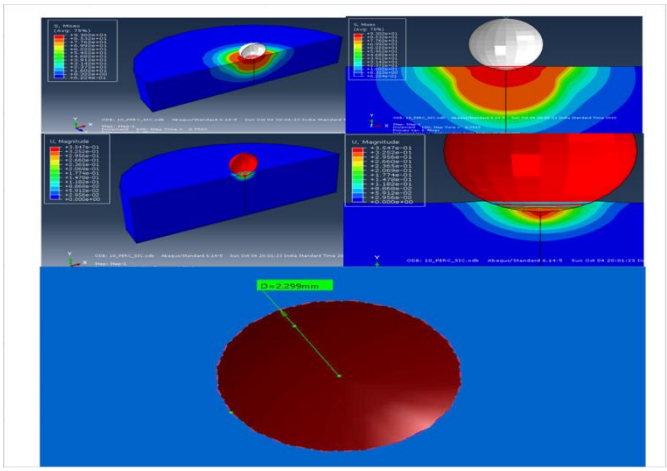
Numerical analysis (FEA)



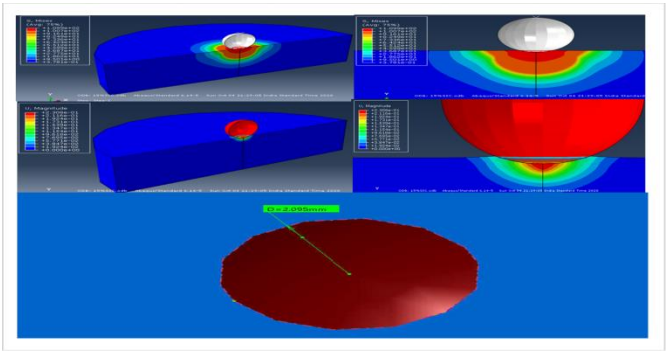
PureAALM12



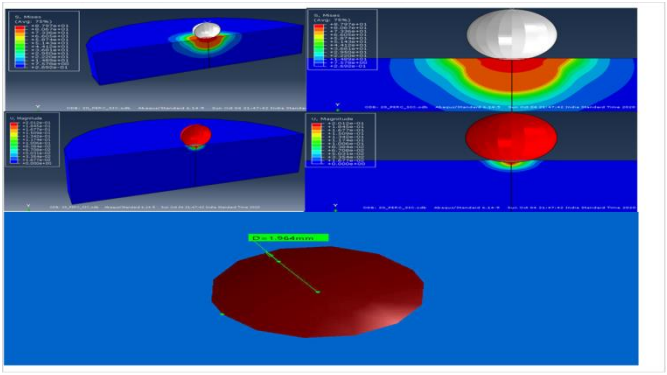
5%SiC



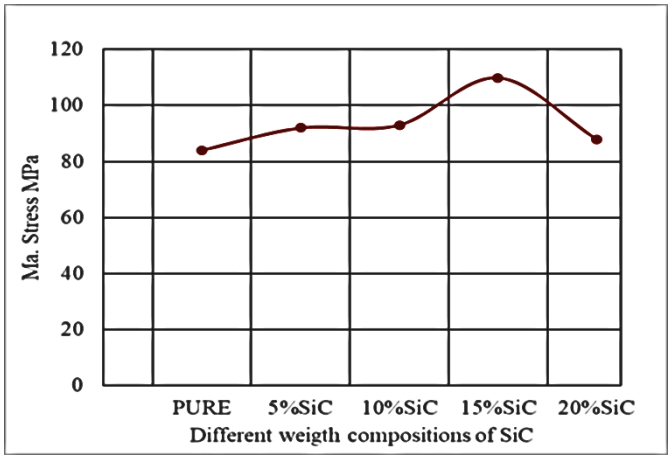
10%SiC

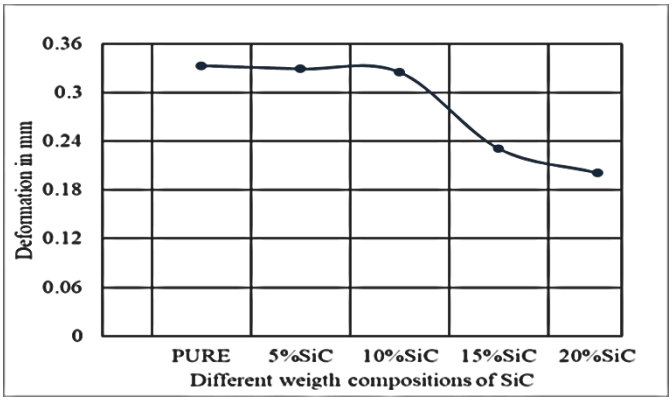


15%SiC



20%SiC





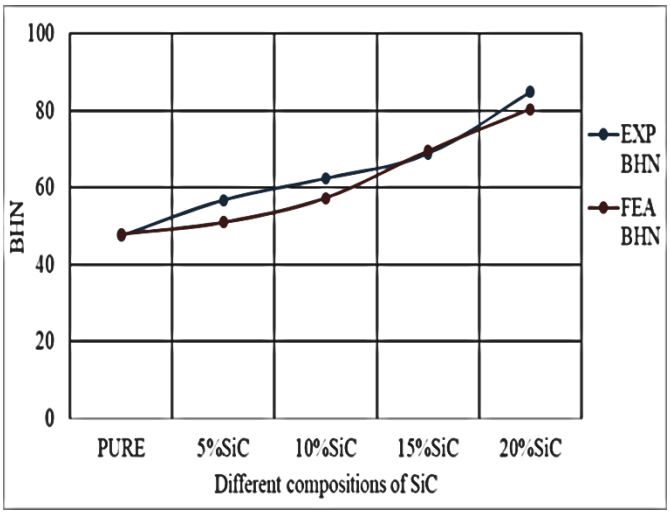
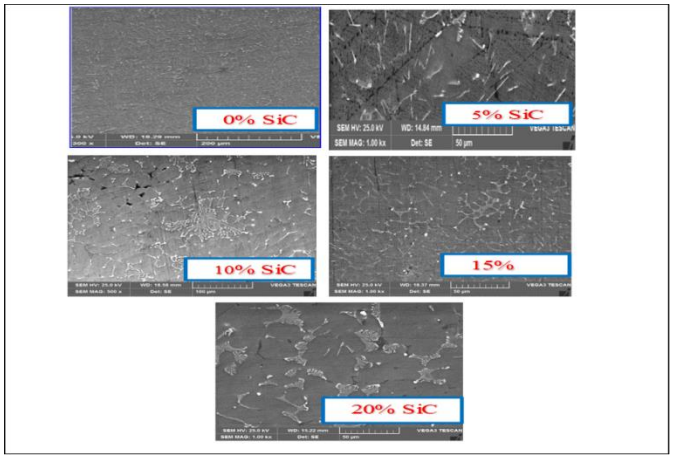


Fig:6 BHN FE analysis results

To prepare the BHN test specimen as per the ASTM standards by using the ABAQUS software and approach the numerically this have been shown in Fig:5.The young's modulus of MMC's increased linearly with increased SiC that shown in fig:4 by using the Karner equation. And the values of yield strength, these are the results are feed in to FE analysisi. The effect of matrix alloy on mechanical properties are shown fig:6 in the influence of matrix alloy on the yieldstrength (YS) of Al-SiC composites. It can be seen that the reinforced with SiC of Al alloy LM12 matrix alloy exhibits larger YS than unreinforced SiC of Al alloys LM12

SEM and EDX analysis



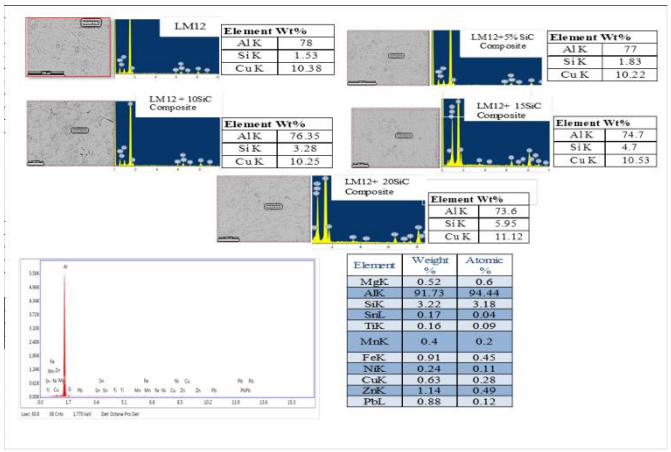


Fig:6 SEM and EDX imag

SEM analysis is carryout the studied of the reinforcements of SiC is distribution and confirmation of inside the matrix are essential to the final properties of composites prepared through stir casting process shown in fig To investigate distribution of reinforcements on composites by using the SEM analysis was performed that observed from the images and it showed that particles were homogenously and uniformly distributed [6]. That showed in SEM images and some clusters of SiC particles are observed in SEM micrographs few researcher

The EDX analysis is observed in the aluminum alloy LM12 metal matrix composites from the SEM images that shown in the fig: 6.10. But Al, Mg and Cu particles are shown inXRD and EDX analysis composites. It shows the qualitative analysis and indicating the presence of Al, Mg, SiC and Cu in the composites material of different reinforced SiC. On the other hand, a high amount of SiC have been indicating due to the surface modification of composites, which are the compositions are having in the composites that is confirmed from this analysisshow in fig:6. [7]

The FEA model of tensile test specimen prepared as per the ASTM E-8 by using ABAQUS software and Finite element analysis at the maximum stress, strain and Deformation at Ultimate tensile strength condition for the different compositions of MMC's[11]

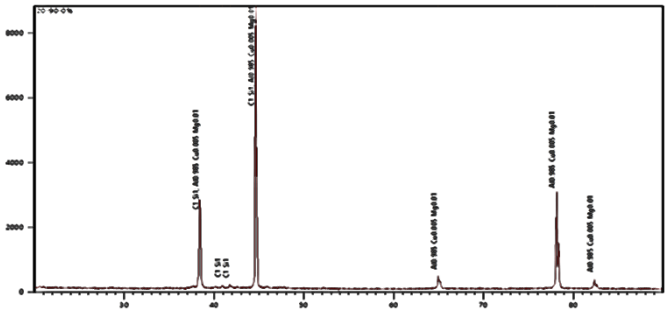


Fig.4 Peak positionsLM12

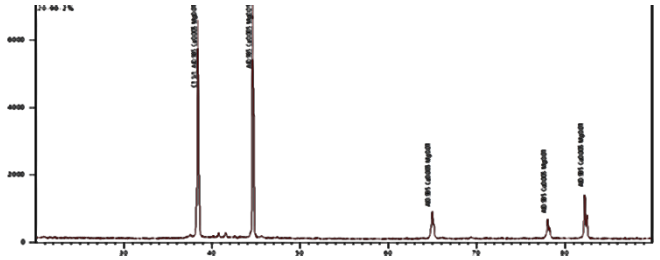


Fig.5 Peak positions-5%SiC

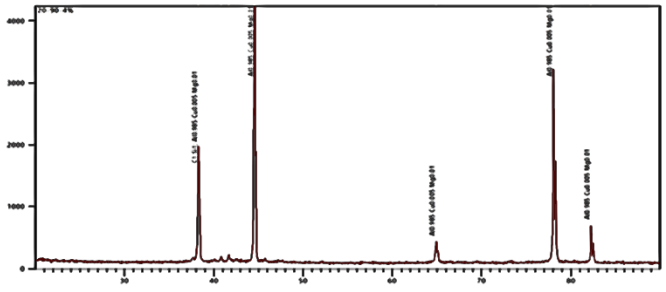


Fig.6 Peak positions-10%SiC

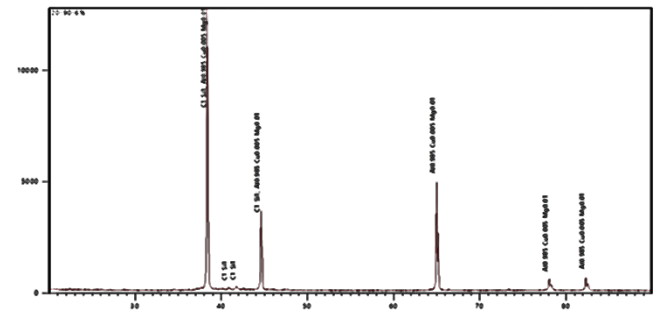


Fig.7 Peak positions-15%SiC

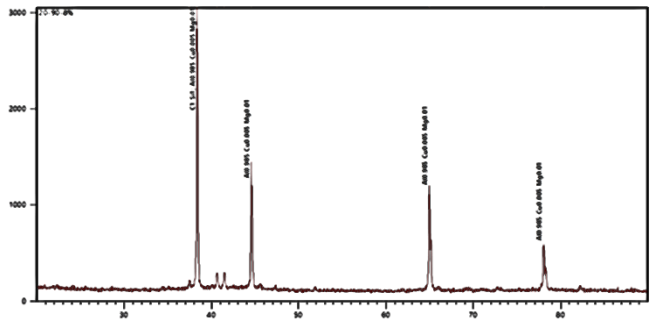


Fig.7 Peak positions-20%SiC

Pos. [°2θ]	Height [cts]	FWHM Left [°2θ]	d-spacing [Å]	Rel. Int. [%]
38.3943	2149.39	0.1437	2.34262	25.92
40.8785	62.84	0.2414	2.20581	0.76
41.7696	60.40	0.3978	2.16079	0.73
44.6330	8292.64	0.0684	2.02858	100.0 0
64.9752	312.02	0.2042	1.43414	3.76
78.1293	2837.74	0.1264	1.22231	34.22
82.3242	246.17	0.1743	1.17033	2.97

Table.2 FWHM& d spacing details for LM12

Pos. [°2θ]	Height [cts]	FWHM Left [°2θ]	d-spacing [Å]	Rel. Int. [%]
37.4953	69.95	0.1674	2.39670	1.10
38.3687	5388.57	0.1221	2.34412	85.02
40.6990	84.93	0.2872	2.21512	1.34
41.4860	118.44	0.2348	2.17490	1.87
44.6185	6338.25	0.0965	2.02921	100.00
64.9519	722.53	0.1920	1.43459	11.40
78.0611	531.18	0.1766	1.22321	8.38
82.2628	1313.36	0.1481	1.17104	20.72

Table3 FWHM& d spacing details for 5%SiC

Pos. [°2θ]	Height [cts]	FWHM Left [°2θ]	d-spacing	Rel. Int.
			[Å]	[%]
38.2765	1472.72	0.1518	2.34956	44.56
40.7896	45.97	0.3925	2.21041	1.39
41.6797	61.15	0.4172	2.16524	1.85
44.5456	3305.33	0.1347	2.03236	100.0
64.8791	301.67	0.1828	1.43603	9.13
78.0355	3112.08	0.1270	1.22355	94.15
82.2445	571.19	0.1305	1.17126	17.28

Table3 FWHM& d spacing details for 10%SiC

Pos. [°2θ]	Height [cts]	FWHM Left [°2θ]	d-spacing [Å]	Rel. Int. [%]
38.3658	10890.18	0.1100	2.34429	100. 00
40.8112	56.69	0.4779	2.20929	0.52
41.7791	78.62	0.6301	2.16032	0.72
44.6180	3113.59	0.1059	2.02923	28.5 9
64.9912	4858.31	0.1043	1.43382	44.6 1
78.0829	466.70	0.1794	1.22293	4.29
82.2926	573.10	0.1622	1.17070	5.26

Table4 FWHM& d spacing details for 15%SiC

Pos. [°2θ]	Height [cts]	FWHM Left [°2θ]	d-spacing [Å]	Rel. Int. [%]
37.4799	63.69	0.2141	2.39765	2.52
38.3656	2530.96	0.1046	2.34430	100.0
40.6601	123.40	0.2030	2.21715	4.88
41.4713	129.25	0.2166	2.17564	5.11
44.5826	1066.27	0.1275	2.03076	42.13
64.9657	1000.97	0.1370	1.43432	39.55
78.0668	426.16	0.1721	1.22314	16.84

Table4 FWHM& d spacing details for 20%SiC

XRD analysis of MMC's

V. RESULTS AND DISCUSSIONS

Comparison of BHN in EXP and FEA

To conduct the BHN test in experimentally, the hardness of MMC's have been increased with increased SiC. Due to the reinforced SiC uniform distribution and made to material highhardened. The specimen prepared in FEA model by using the ABAQUS software after that the young's modulus of MMC's calculated by using the Karner equation these values and experiment yield strength values are feed in to the FEA model.in the influence of SiC of matrix alloy on the yieldstrength and Youngs modulus of Al-SiC composites it has been increases shown in fig:. The comparison of the BHN test results in experimentally and FE analysis both results are increased linearly and correlated, The maximum stress correlated each other and deformation of MMC's in experiment and FE analysis decreased gradually that phenomenon also shown in fig:7.

Compositions	EXP BHN	FEA BHN	Max, Stress Mpa	Deformation in mm
PURE	47.5	47.95	84.01	0.333
5%SiC	56.8	51	91.98	0.329
10%SiC	62.4	57.36	93.02	0.325
15%SiC	68.8	69.57	109.9	0.231
20%SiC	84.8	80.44	87.97	0.201

Fig:7 Results comparison

SEM, EDX and XRD analysis

That showed in SEM images and some clusters of SiC particles are observed in SEM micrographs for the confirmed in the composites. The EDX analysis is observed in the al alloy LM12 metal matrix this composites from the SEM images that shown in the fig:6. But Al, Mg and Cu particles shows SEM image,XRD and EDX pattern A Alloy LM12composite. It shows the qualitative analysis, indicating the presence of Al, Mg, SiC and Cu.

VI. CONCLUSION

Based on the results of this investigation following conclusions were drown

1. Aluminum alloy LM12-SiC composites were prepared by using the stir casting techniques and 23micron meter size of SiC have been used as reinforcement. Succeffully,
2. The tensile yield strength and Young's modulus of metal matrix composites Increased with incorporation of silica carbide. Higher amount of silica carbide shows more influence on properties those values are feed into FEA of BHN test.
3. The maximum stress is increased in both the cases like experiment and FEA, The BHN results are also increased with increased SiC in both cases and results are correlated and deformation have been decreases with increased SiC in experiment and FEA results are correlated and these results are obtained from the ABAQUS software followed the standard procedure.
4. The reinforcement of SiC uniformlydistribution in metal matrix composite and this is confirmed by using the SEM, EDX and XRD analysis.

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National Conference on Recent Advances in Mechanical Engineering and Materials
International Journal of Scientific Research in Mechanical and Materials Engineering
2021 IJSRMME | Volume 4, Issue 7 | ISSN : 2457-0435

Synthesis and Characterization of Aluminium and Silicon Carbide Based Functionally Graded Metal Matrix Composite

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ABSTRACT

Functionally Graded Metal matrix composites are one of the emerging materials in material science and engineering applications. The functionally graded composites have wide variety applications in different fields of engineering because the properties of the FGM materials can be tailored by changing the microstructure of the materials along any direction. Functionally graded composite materials can be manufactured by different methods such as Centrifugal casting, powder metallurgy, deposition methods etc. In this work aluminium based functionally graded composite is synthesized and analyzed for its mechanical characteristics. Silicon carbide particles are used as reinforcement in producing the functionally graded composite.

Keywords : Aluminium, Silicon Carbide Particles, Centrifugal Casting, Functionally Graded Materials

I. INTRODUCTION

Metals have played a very vital role in the advancement of mankind and it has been a continuous journey of scientific endeavors to explore their behavior and to expand the horizons of their applications. Metallic alloys are homogeneous mixtures of two or more materials, one of them is necessarily the base metal which is mixed with constituent materials to result enhancement of properties of the base metal.

At the same time, we are witnessing an exponential growth in development and applications of composite materials in last few decades. Contrary to alloys, composites are heterogeneous mixtures of a wide range of reinforcements to the base material (commonly known as matrix). Composites club the benefits of both the matrix and the reinforcements.

Metal Matrix Composites (MMCs) are composed of a metallic matrix (aluminium, magnesium, iron, cobalt, copper etc.) and a dispersed medium of ceramics (oxides, carbides etc.) or metallic particles (lead, tungsten, molybdenum etc.). The influence of size of reinforcement also present a very interesting scope of study.

Functionally Graded materials (FGMs) are the recent developments in the field of material science, but naturally we are surrounded with FGMs. Bones, human skin and bamboo are some of the examples of naturally available functionally graded materials. Functionally Graded Materials are the materials in which composition changes gradually in a preferred direction or axis. This graduation makes the FGMs superior relative to homogeneous materials. The application of FGMs includes heat exchanger, flywheels, turbine blades and so on where abrupt change in material is not desired. The gradual variation in composition of FGM makes the material to have different properties depending on the variation of composition.

Aluminium is one of the most important materials that finds applications in every walk of life. Pure aluminium is soft, ductile, corrosion resistant and has a high electrical conductivity. It is widely used for foil and conductor cables, but alloying with other elements is necessary to provide higher strengths needed for structural applications. Aluminium is one of the lightest engineering metals, having a strength to weight ratio superior to that of steel.

Silicon carbide (SiC) also known as carborundum is a semiconductor and contains silicon and carbon. Grains of silicon carbide can be bonded together by sintering to form very hard ceramics that are widely used in applications requiring high endurance, such as car brakes, clutches and ceramic plates in bulletproof vests. Silicon carbide is an excellent abrasive and is very widely used in grinding wheels and in other abrasive products. Silicon carbide is an important non-oxide ceramic which has diverse industrial applications. In fact, it has exclusive properties such as high hardness and strength, chemical and thermal stability, high melting point, oxidation resistance, high erosion resistance, etc. All of these qualities make SiC a perfect candidate for high power, high temperature electronic devices as well as in abrasion and cutting applications.

Centrifugal casting or roto casting is a casting technique that is typically used to cast thin-walled cylinders. It is typically used to cast materials such as metals, glass, and concrete. A high quality is attainable by control of metallurgy and crystal structure. Unlike most other casting techniques, centrifugal casting is chiefly used to manufacture rotationally symmetric stock materials in standard sizes for further machining, rather than shaped parts tailored to a particular end-use.

II. LITERATURE

Ebhota et al comprehensively presents throwing systems and their uses, practically reviewed metal framework composites (FGMMCs). Contemplations were given to practically reviewed aluminum lattice composites (FGAACs) creation forms. Fluid metal producing procedures of FGAACs creation, for example, penetration process, crush throwing, erosion throwing or compo casting, mix, and diffusive throwing were discussed [1]. The section gives essential ideas of the procedures and outline of their handling parameters, for example, form rotational speed; fortification particles size and volume; degassing technique; liquefying and pouring temperatures; weight; and stirrer. The examination noticed that practically evaluated materials (FGMs) are regularly utilized in car, flying machine, aeronautics, synthetic, therapeutic, designing, sustainable power source, atomic vitality, and optics hardware industry.

The real necessity for progression in engineering& innovation is to give high caliber of throwing item to all driving assembling enterprises. Al compound is one of the propelled materials that is utilized for high caliber of throwing item because of its high accessibility and minimal effort, yet unadulterated Al is delicate and fragile that is the reason it doesn't meet with the prerequisite of different assembling businesses. In any case, it very well may be fortified by including fortifying material and it is known as Al compound or metal network composite. MMC can be gotten by accepting metal as network and hard molecule/earthenware production as support. It has wide scope of utilization with air scope, car atomic, biotechnology, and gadgets ventures. Its property is additionally relying on assembling strategies, heat treatment and its procedure parameter. This study gives an outline on Al composites material and its manufacture strategy. This study additionally gives survey on the impact of fortification material on Al compound and the impact of procedure parameter of radiating castings [2].

[3] Rajesh et al, has discussed the grid amalgam, the fortification material, the volume and state of the support, the area of the support, and the creation technique would all be able to be fluctuated to accomplish required properties. Metal matrix composites (MMCs), for example, SiC molecule strengthened Al, are one of the generally known composites in light of their unrivaled properties, for example, high quality, hardness, firmness, wear and consumption.

[4] Karvanis et al have studied the use of Al-SiC Metal Matrix Composites is continually expanding in the most recent years because of their one of a kind properties, for example, light weight, better properties when compared to other metals, high explicit modulus,, high hardness and low thickness. Al-SiC composites of different carbide arrangements were created utilizing a diffusive centrifugal casting machine. Checking electron microscopy was utilized to think about the microstructure-property relationship. It was seen that the elastic and the compressive quality of the composites expanded as the extent of silicon carbide ended up higher in the composites. Additionally, with expanding extent of silicon carbide in the composite, the material ended up more earnestly and seemed to have littler qualities for all out dislodging and absolute vitality amid effect testing

In this research work, aluminum-silicon carbide (Al-SiC) metal matrix composites (MMCs) of various composition layers were set up under various compaction loads. Three distinct sorts Al-SiC composite examples having 10%, 20% and 30% volume divisions of silicon carbide were manufactured utilizing traditional powder metallurgy (PM) course. The examples of various structures were set up under various compaction loads 10 ton and 15 ton. The impact of volume division of SiC particulates and compaction load on the properties of Al/SiC composites were examined. The got outcomes demonstrate that thickness and hardness of the composites are incredibly impacted by volume portion of silicon carbide particulates. Results likewise demonstrate that thickness, hardness and microstructure of Al-SiC composites are fundamentally impacted relying upon the compaction load [5]. The expansion in the volume portion of SiC improves the thickness and hardness of the Al/SiC composites. For 15-ton compaction load, the composites show expanded thickness and hardness just as improved microstructure than the composites arranged under 10-ton compaction load. Moreover, optical micrographs uncover that SiC particulates are consistently disseminated in the Al network

III. METHEDOLOGY

Functionally graded aluminium silicon carbide metal matrix composite was produced using centrifugal casting machine at a constant mould rotation speed of 1000 rpm. In this experimental procedure aluminium 1100 is used as base metal or reinforcement. The properties of Al 1100 is given in the below Table 1. The silicon carbide used in this study is of 50μm of particle size.

TABLE 1: Properties of aluminium

Property	Value
Density	2700 kg/m3
Melting point	Around 660°C
Composition	Al (99.6%)
Corrosion Resistance	Excellent
Anodizing	Good
Formability	Good
Machinability	Good
Weldability	Good

In this study four specimens were created with 0, 5, 10 and 15% of SiC particle by volume with base metal aluminium 1100. To melt the metals an electric arc furnace was used. Initially the Crucible made up of

graphite is preheated then the aluminium powders were poured into it. Then the Crucible is heated till the aluminum melts completely. To this molten metal reinforcement were added according to the table 2 to prepare four specimens.

TABLE 2: Composition of each specimen

Specimen	Aluminium (%) by volume	SiC (%) by volume	SiC by weight
Specimen 1	100	0	0 g
Specimen2	95	5	77.4 g
Specimen 3	90	10	154.81 g
Specimen 4	85	15	232.226 g

The furnace used is electric resistance furnace with maximum temperature of 1400°C. Where heating coils are made up of Silicon Carbide, and platinum sensors are used. The furnace is checked up to the final temperature.

After the final temperature of the furnace is been checked the crucible is been placed into the furnace and it is preheated up to 300°C. The crucible is made up of Graphite which can resist up to 4000°C.

After preheating of the crucible required amount of Aluminium is added into the crucible and the furnace is closed and temperature is set to 1050 C and the furnace is left until Aluminium is melted to a molten state.

When Aluminium reaches its molten state Silicon Carbide is added (Figure 1) according to the ratio required and it is stirred until it is well mixed with Al.

Fig 1: Addition of Silicon Carbide

After the estimated duration, the furnace lid is opened. Using stirrer Aluminium and Silicon Carbide are uniformly stirred, the crucible is taken out from the furnace. The centrifugal casting machine is cleaned thoroughly for clearance of chips and dust. The centrifugal casting machine (Figure 2) is turned on and set at constant speed of 1000 rpm.

The pouring basin is adjusted accordingly to pour the molten metal (Figure 3). The mixture of aluminium and SiC particles in molten stage from the furnace is removed using tongs after mixing. And the same mixture is poured into the rotating die placed inside the casting machine using pouring basin.

Fig 2: Centrifugal Casting Machine

After the mould gets solidified, the centrifugal casting die cap is removed, and by using tong the cast is removed from the die and placed on a sand container. The same procedure is followed for all four specimens.

Fig 3: Pouring basin

IV. TESTING

A. Hardness test

Brinell hardness test was performed to measure the hardness of the specimen. Three regions were identified in the specimen. The hardness was measured at three different regions of the specimen, one at outer region, middle region and inner region. For all the four specimens the BHN values are compared at different regions. In Brinell hardness test ball type of indentation was used with the applied load of 250kg. The diameter of indentation was 10mm.

Test Procedure for Brinell hardness

1. Prepare the Sample to be testing by smooth Polishing Surface.
2. Place the sample on the Instrument.
3. Apply the load of 250 kg with 10mm ball for 10Sec.
4. Remove the Sample and measure the indentation using microscope.
5. Calculate and report for same.

B. Tensile test

The specimen used for tensile test was of ASTME E8M standard (Figure 4). The tensile test conducted on the specimen from an Universal tessting Machine of capacity 0 to 20 tons.

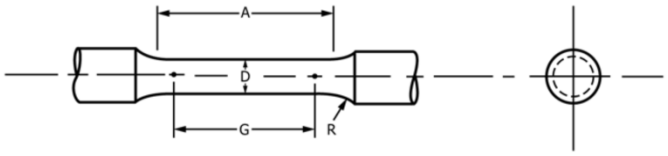

Fig 4: Tensile test dimensions

Test Procedure for Tensile Testing

1. Prepare the Test Specimen as specified in Indian Standard (IS 1608/ASTM E8M)
2. After Specimen receipt check for the dimensions is as per the specified standard, if found ok process for test
3. Punch for Gauge length mark on the sample and measure the Initial Gauge Length.
4. Hold the Specimen to the fixtures and gradually apply the Load
5. Stops the test when the tensile Specimen Breaks
6. Arrange the Specimen to check for the Final Gauge Length
7. Calculate for Tensile, yield strength and elongation and report for same with Graph

C. Microstructure

Optical microscope of 100x and 400x magnification was used to study the microstructure of the produced samples. The outer region is studied under 100x magnification and middle region was observed under 400x magnification. The same standard procedures are used for studying microstructure of all the specimens.

Test Procedure for Microstructure observation

1. Select the region and cut the sample.
2. Grind the specimen using successive fine emery papers and metallographic polish
3. Etch with suitable etching agent like 0.5% HF
4. Observe under metallurgical microscope at different magnification.

V. RESULTS AND DISCUSIONS

A. Hardness test results

In the hardness test (middle) we have seen that, there is decrease in the hardness for trial 2 and 3 and again there is slight increase in the hardness. In the hardness test inner the hardness reduced for the trial 2 further hardness has slight increase in the hardness. Ignoring any discrepancies during casting, we can consider the trial 4 to be the most desirable material due to high yield strength. But it is also possible that the casting may have been inconsistent and therefore there are so many variations in hardness.

TABLE 3: Hardness each specimen

	Hardness		
	Outer	Middle	Inner
	BHN	BHN	BHN
PURE ALUMINUM	21.75	21.75	21.75
5% SIC	20.65	19.60	18.60
10% SIC	20.65	19.60	19.60
15% SIC	19.60	20.65	19.60

B. Tensile test results

According to ASTME E8 standard the specimens were created and tensile tests were conducted. The results of the tensile test reviles that that yield strength has increased for the trial 4 i.e., 15% of SiC in 85% of aluminium. Also, it decreases suddenly at the trial 3 i.e., 10% of SiC in 90% aluminium and, it gradually increases since then.

TABLE 4: Yield strength of each specimen

	Yield Strength
PURE ALUMINUM	58.546 MPa
5% SIC	58.578 MPa
10% SIC	56.77 MPa
15% SIC	65.71 MPa

C. Microstructure results

For all the specimens the microstructure was studied at two different regions one at the outer region and at the middle region and the results were compared. Following images gives the information about the microstructural results.

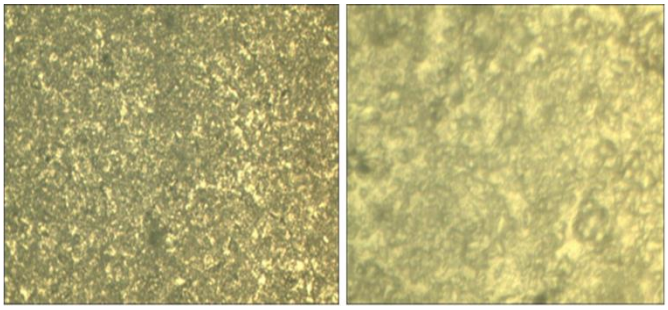

Fig 5: Microstructure of 5% SiC reinforced aluminium composite at outer and middle region at 100x and 400x composition respectively

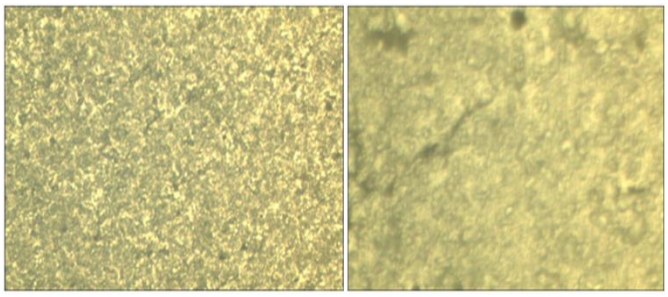

Fig 6: Microstructure of 10% SiC reinforced aluminium composite at outer and middle region at 100x and 400x composition respectively

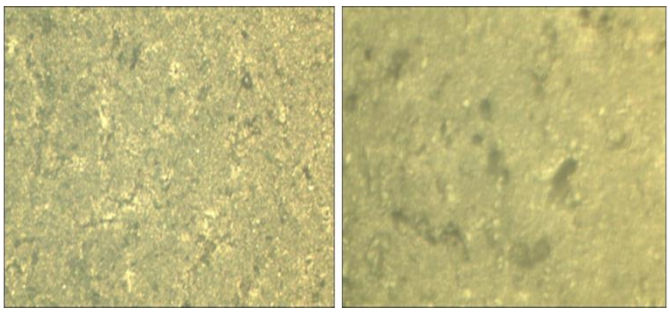

Fig 7: Microstructure of 15% SiC reinforced aluminium composite at outer and middle region at 100x and 400x composition respectively

From all the microstructural images it was found that the amount of SiC particle are found more at the

outer region than in middle region. This is because the SiC particles have higher density which makes them to move away from the center at the high rotational speed due to centrifugal force.

VI. CONCLUSION

This work represents the study of Silicon Carbide reinforced aluminium alloy in even ratios and how it performs under various tests. After the test results and discussion, we can conclude that for required properties, the above-mentioned ratios can be used. However, the degree of improvement of hybrid reinforcements in aluminium alloys still need to be studied.

As the percentage of the Silicon Carbide increases till 10%, the yield strength of the material will decrease and then it increases for the 15% of Silicon Carbide. Since solidification is also main parameter for the required properties, air cooling was done after the casting process.

The optical microscope revealed a reasonably non-uniform distribution of Silicon Carbide particles in the matrix. Optical microscope confirmed the validation of manufactured composites. The microstructure of specimens (5%, 10%, 15%) of magnification 100X at the outer region and 400X at the middle region of the casted specimen is obtained.

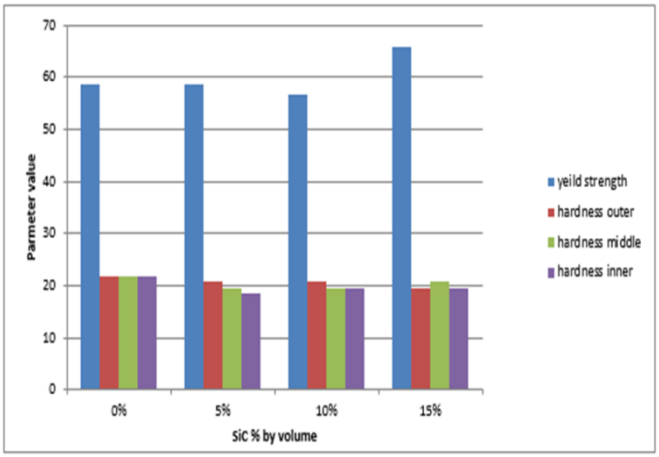

Fig 8: Bar graph showing tensile and hardness results

Functionally graded metal matrix composites made of commercially pure aluminium reinforced with SiC has been fabricated successfully through horizontal centrifugal casting technique. Different weight fractions (0%, 5%, 10%, and 15%) of SiC have been investigated. Same rotational speeds of 1000 rpm is used. Investigation of microstructure reveals that the concentrations of the SiC particles in the outer zone of the cast tubes reach its maximum value followed by a gradual decrease in the direction of inner diameter. In case of large particle sizes and higher rotational speeds, all fabricated tubes revealed high concentration of reinforcing particles in the outer zone due to higher centrifugal force and particle mass.

VII. SCOPE FOR FUTURE STUDY

- The results can be studied by varying the percentage of the SiC in small range.
- By changing the rpm of the Centrifugal Casting Machine, the characteristics can be studied.
- Preheating the mould before pouring the motel metal into it will give better results.
- By varying the grain size of SiC particles.
- Still better processing techniques needs to be developed for better results.

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National Conference on Recent Advances in Mechanical Engineering and Materials
International Journal of Scientific Research in Mechanical and Materials Engineering
2021 IJSRMME | Volume 4, Issue 7 | ISSN : 2457-0435

Analysis of XRD and EDS for the Aluminum Alloy7075/ 500nm Sic Metal Matrix Composites, the BHN Test Experimental Results Are Comparison by FE Simulation Tests

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ABSTRACT

The aluminum alloy is having one of the superior material properties which is used in different industrial sectors like aerospace, automobile and general engineering industries because of their favorable microstructure and mechanical behavior. Research shows that The Metal matrix composites of aluminum alloy reinforced with silicon carbide reinforcement have exhibited enhanced mechanical properties. In this work, Composites of aluminum alloy AA7075 reinforced with 500nm silicon carbide were fabricated by using popular method of stir casting techniques.

Addition of Silicon carbide was made in weight percentage in the range of 0 to 8% respectively. Further XRD and EDS was conducted for the samples. Hardness test was carried out for the MMC specimens using Brinnel Hardness Testing Machine. Results showed improved hardness for the increased SiC content in the Specimens. FEM Analysis was carried out using axisymmetric method to obtain enhanced hardness values for the MMC's, Both Experimental and FEM results were compared in this work.

Keywords : 500nmSiC, AA7075, MMC's Fabrication, BHN test with FEA by using ABAQUS software, XRD and EDS analysis.

I. INTRODUCTION

Metal matrix composites are obtained by popular aluminum alloy series such as 2XXX, 3XXX,6 XXX & 7XXX etc. Which are mainly used in aircraft structure design due to their high strength and weight ratio. Due to the demand in high performance of the aircrafts weight reduction methods are used in aviation sector and new materials are under search.(1-5). Aluminum alloys reinforced with Nano size of silicon carbide (MMC's) have shown greater signs in order to decrease the weight and consequently proved to be better structural components to provide strength to the structure. Vast research work has been undergoing in the area of MMC's. Because of their weight to strength ratio, MMC's are gradually replacing the popular

aluminum .alloys which were used post world war in Aircraft and in other applications (6-10).

II. EXPERIMENTAL DETAILS

II.1 Materials

Present work describes the production of MMC's by using stir casting technique tensile test with FEA, analysis and density and porosity of Al7075 Aluminium alloy with reinforcement of silicon carbide with various %wt and compositions of AA7075 shown in below fig.

Element	Wt.%	Element	Wt%
Copper	1.6	Zinc	5.5
Magnesium	2.5	Chromium	0.15
Silicon	0.4	Titanium	0.2
Iron	0.5	aluminum	Balance
Manganese	0.3		

Table:1 Composition of the Al7075

II.2 Fabrication of Composites

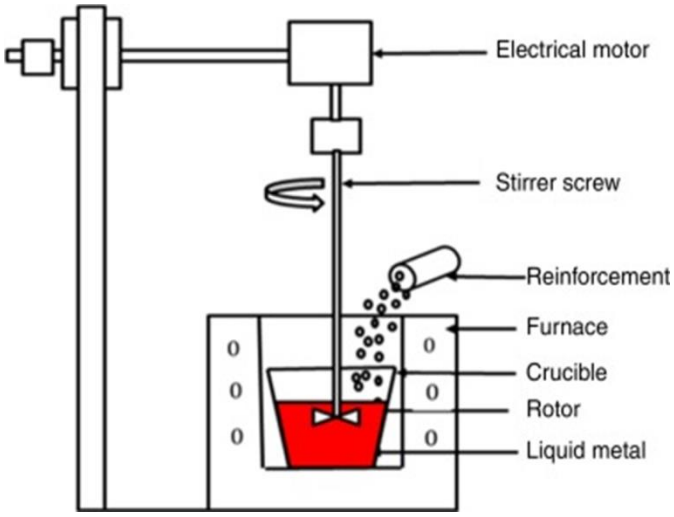


Fig: 1 Stir casting set up

The MMC's were fabricated by using the stir casting technique that setup have been shown in the fig:1. The AA 7075 is kept into the crucible furnace and supply to heat by using the electric heating source, when it is reaches to the temperature 6000C -7500C the AA7075 is melted in crucible than pour the weight % of SiC in the molten metal while stirs the stir by using the electrical motor. Similarly fabricated the MMC's at different weight % of SiC.

II.3 Experimental work

II.4

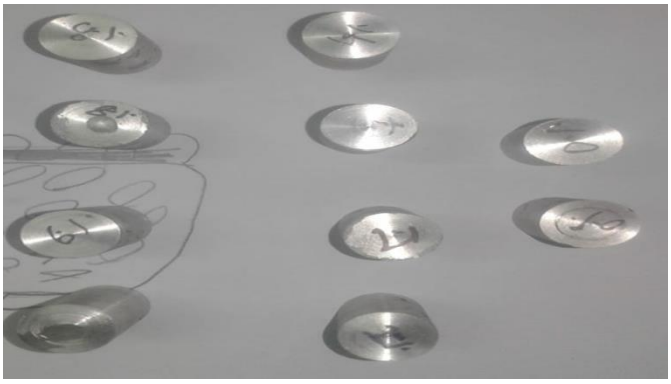


Fig 2.BHN Test samples

Hardness specimens were machined as per ASTM: E10. Using BHN machine setup, with a load of 250Kgf on the 5mm dia indenter Load was applied for all the specimens and depression diameter was measured for each of the specimens. Using empirical formulae, hardness (BHN) was estimated and it was observed that hardness increased with the weight percentage of SiC. And also the deformation of the material decreased with increase in SiC weight%.

Fig.3 BHN Machine set up

A. XRD and EDX analysis of MMC's

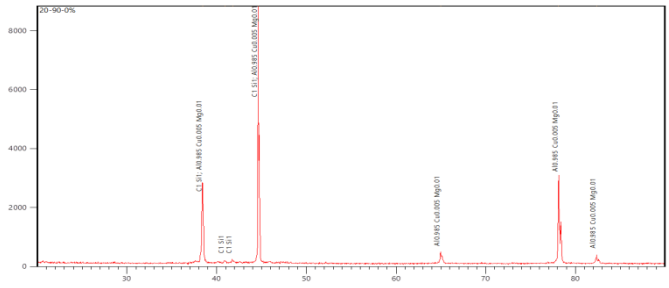


Fig.4 Peak positions-AA7075

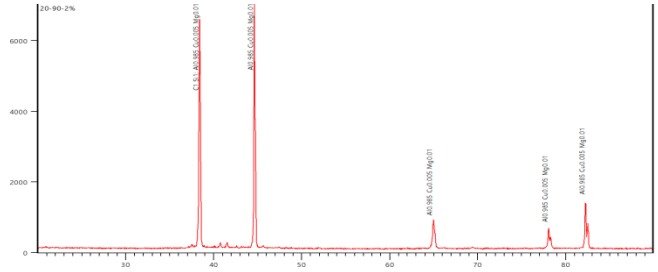


Fig.5 Peak positions-2%SiC

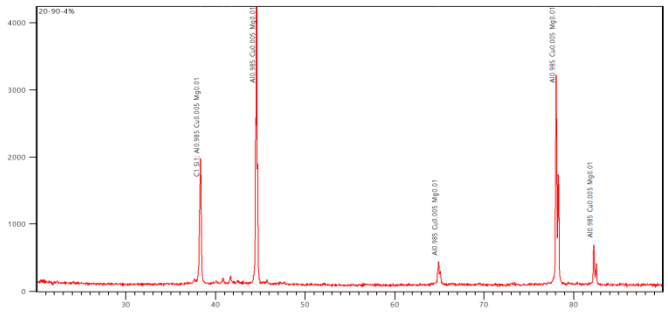


Fig.6 Peak positions-4%SiC

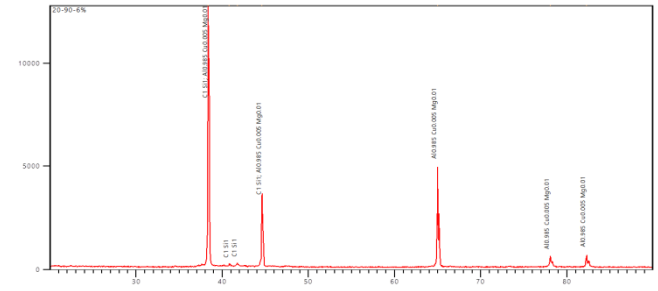


Fig.7 Peak positions-6%SiC

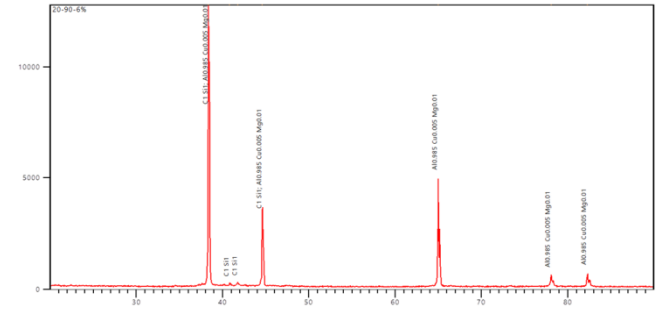


Fig.7 Peak positions-6%SiC

Pos. [°2θ]	Height [cts]	FWHM Left [°2θ]	d-spacing [Å]	Rel. Int. [%]
38.3943	2149.39	0.1437	2.34262	25.92
40.8785	62.84	0.2414	2.20581	0.76
41.7696	60.40	0.3978	2.16079	0.73
44.6330	8292.64	0.0684	2.02858	100.00
64.9752	312.02	0.2042	1.43414	3.76
78.1293	2837.74	0.1264	1.22231	34.22
82.3242	246.17	0.1743	1.17033	2.97

Table.2 FWHM& d spacing details for AA7075

Pos. [°2θ]	Height [cts]	FWHM Left [°2θ]	d-spacing [Å]	Rel. Int. [%]
37.4953	69.95	0.1674	2.39670	1.10
38.3687	5388.57	0.1221	2.34412	85.02
40.6990	84.93	0.2872	2.21512	1.34
41.4860	118.44	0.2348	2.17490	1.87
44.6185	6338.25	0.0965	2.02921	100.00
64.9519	722.53	0.1920	1.43459	11.40
78.0611	531.18	0.1766	1.22321	8.38
82.2628	1313.36	0.1481	1.17104	20.72

Table.3 FWHM & d spacing details for 2%SiC

Pos. [°2θ]	Height [cts]	FWHM Left [°2θ]	d-spacing [Å]	Rel. Int. [%]
38.2765	1472.72	0.1518	2.34956	44.56
40.7896	45.97	0.3925	2.21041	1.39
41.6797	61.15	0.4172	2.16524	1.85
44.5456	3305.33	0.1347	2.03236	100.0
64.8791	301.67	0.1828	1.43603	9.13
78.0355	3112.08	0.1270	1.22355	94.15
82.2445	571.19	0.1305	1.17126	17.28

Table.4 FWHM & d spacing details for 4% SiC

Pos. [°2θ]	Height [cts]	FWHM Left [°2θ]	d-spacing [Å]	Rel. Int. [%]
38.3658	10890.18	0.1100	2.34429	100.00
40.8112	56.69	0.4779	2.20929	0.52
41.7791	78.62	0.6301	2.16032	0.72
44.6180	3113.59	0.1059	2.02923	28.59
64.9912	4858.31	0.1043	1.43382	44.61
78.0829	466.70	0.1794	1.22293	4.29
82.2926	573.10	0.1622	1.17070	5.26

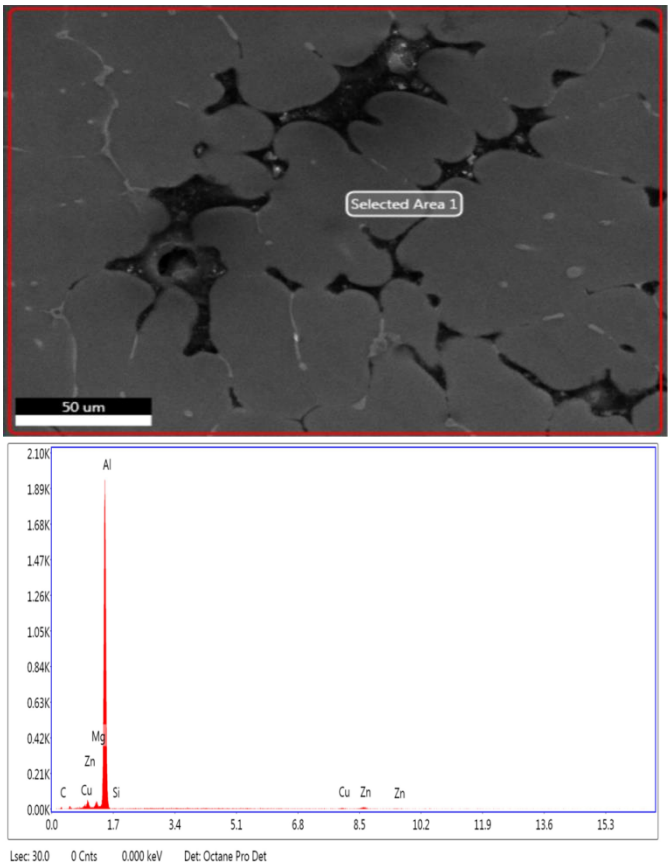
Table.5 FWHM & d spacing details for 6% SiC

Pos. [°2θ]	Height [cts]	FWHM Left [°2θ]	d-spacing [Å]	Rel. Int. [%]
37.4799	63.69	0.2141	2.39765	2.52
38.3656	2530.96	0.1046	2.34430	100.0
40.6601	123.40	0.2030	2.21715	4.88
41.4713	129.25	0.2166	2.17564	5.11
44.5826	1066.27	0.1275	2.03076	42.13
64.9657	1000.97	0.1370	1.43432	39.55
78.0668	426.16	0.1721	1.22314	16.84

Table.6 FWHM & d spacing details for 8% SiC

XRD Patterns list and peak intensities, positions were obtained from Diffractometer system=XPERT-3.for the MMC samples. Fig (4) to Fig.(7) show the peak intensities and positions and Table.(2) to Table (6) show the corresponding Full width half max and the spacing of the crystals XRD tests confirmed the crystallite size of the SiC and its cubic structure.

Energy dispersive X-ray (EDX) analysis



Element	Weight %	Atomic %
C K	9.71	19.95
MgK	1.79	1.82
AlK	83.02	75.95
SiK	0.39	0.34
CuK	1.5	0.58
ZnK	3.6	1.36

Fig:8 EDX analysis of MMC's

B. BHN test of MMC's by using FE analysis

FEM analysis was carried out for this BHN test considering axisymmetric of the indenter and the specimen. Therefore half of the 2Dimensional geometries of indenter and specimen were modelled and analyzed for the given Load of 250Kg. ABAQUS was used to carryout FEM analysis and the details of FEM have been shown in Figures Below. As a First step,

axisymmetric rigid body for indenter and axisymmetric deformed body for specimen were created. And shown in fig 9. And fig 10. Respectively.

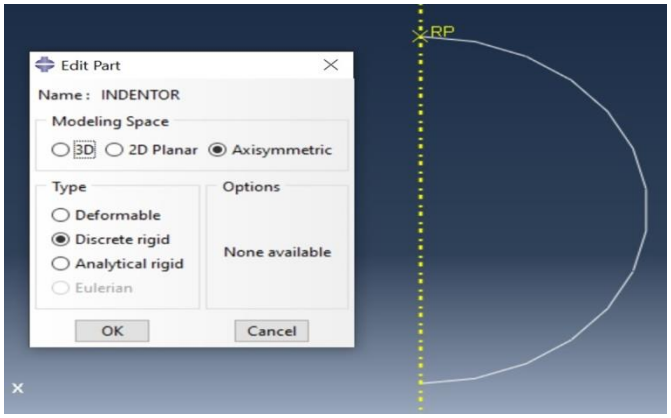


Fig: 9 Indenter Geometry

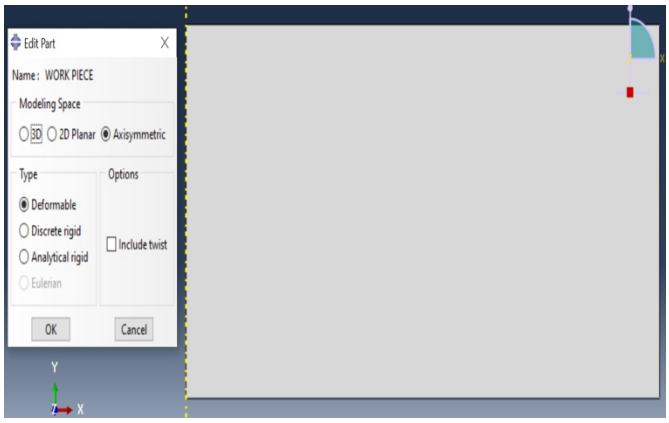


Fig 10. Axisymmetric Specimen

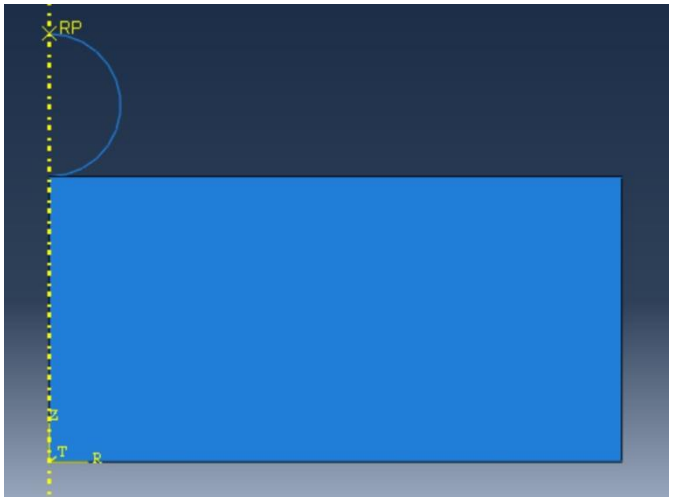


Fig 11. Indenter & Specimen

Boundary Conditions

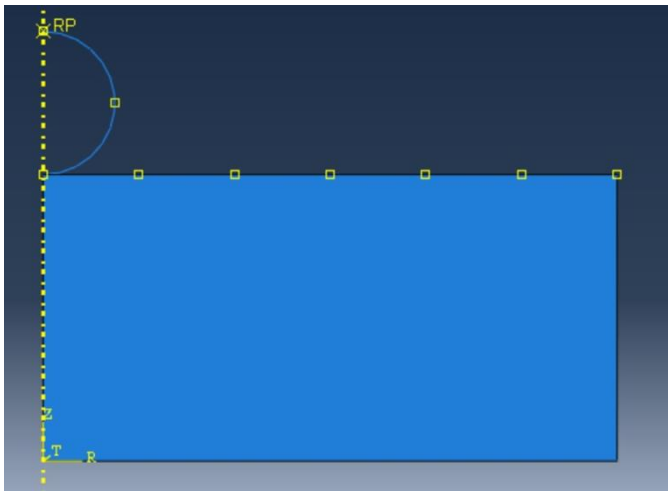


Fig 12. Contact made between slave surface of specimen and indenter

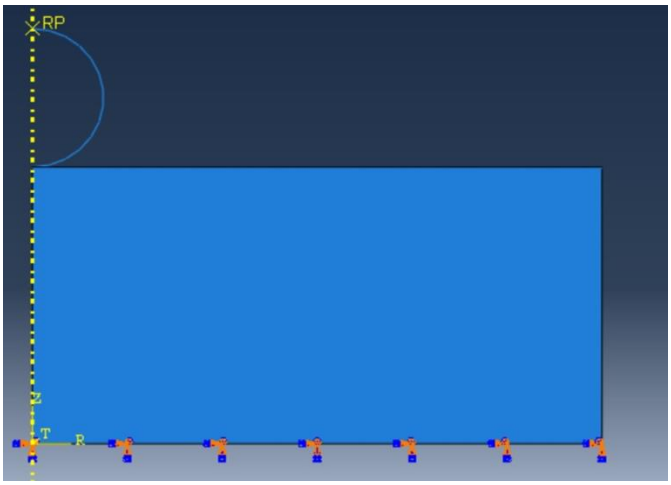


Fig 13. Bottom surface Fixed

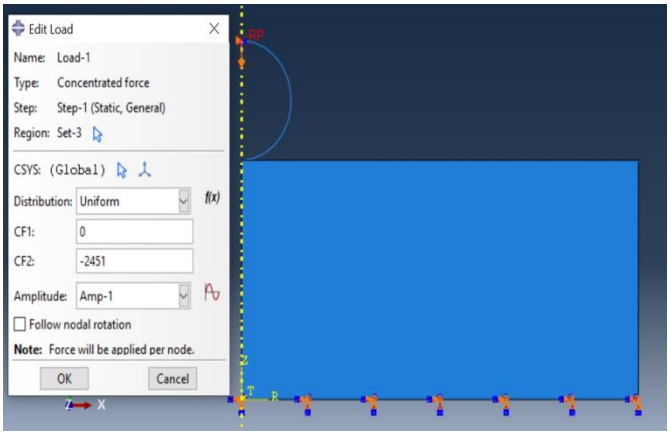


Fig.14. Force of 250Kg applied on Indenter

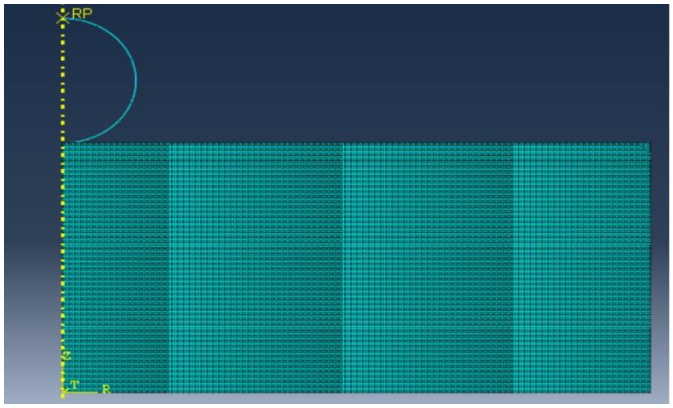


Fig.15. Meshed Model

In Figures.12, 13, 14 we can see the boundary conditions where top surface of the specimen is made in contact with indenter surface and bottom surface of the specimen is fixed. And a force of 250Kg is applied at the top end of the indenter.

C. Element Type Used

Axisymmetric Linear Quadrilateral 4noded (CAX4R) were chosen for specimen mesh. And 2 node linear axisymmetric (discrete rigid element-RAX2) were used to mesh the indenter. Fine mesh was created in order to obtain accurate results. Total no.of elements used were 14212 and 14798 nodes were added.

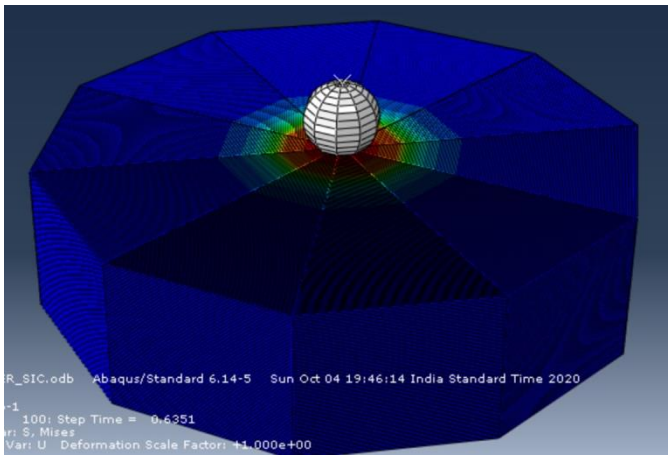
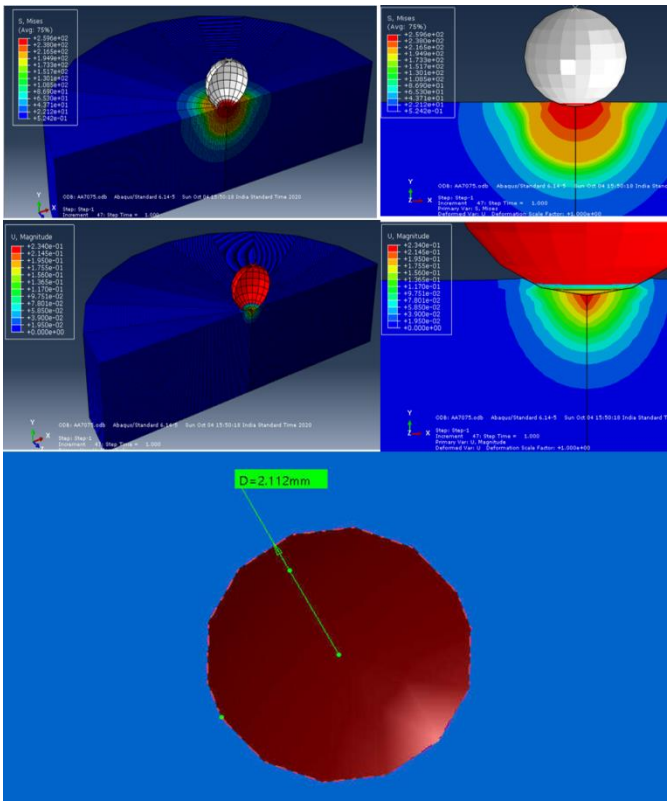
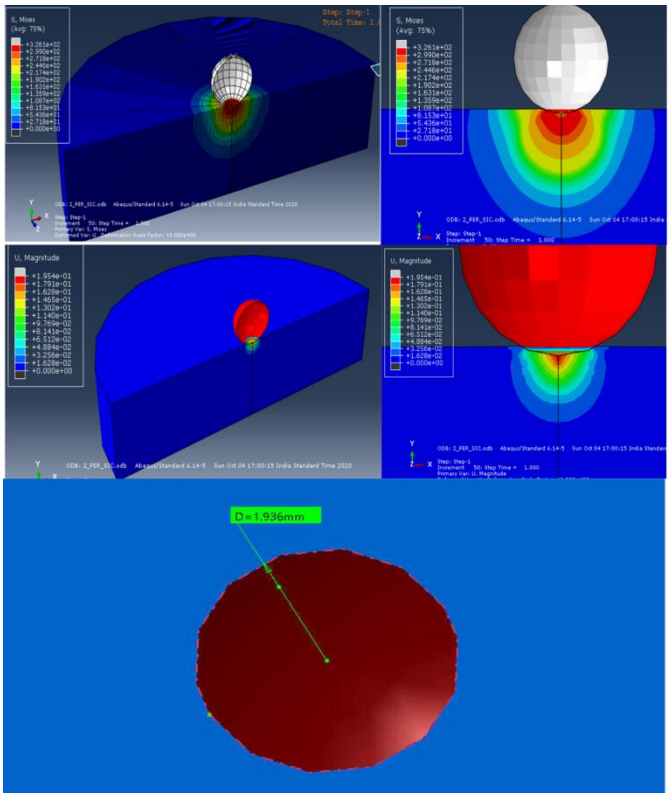


Fig. 15 Entire FE Model for BHN

D. FEM Results





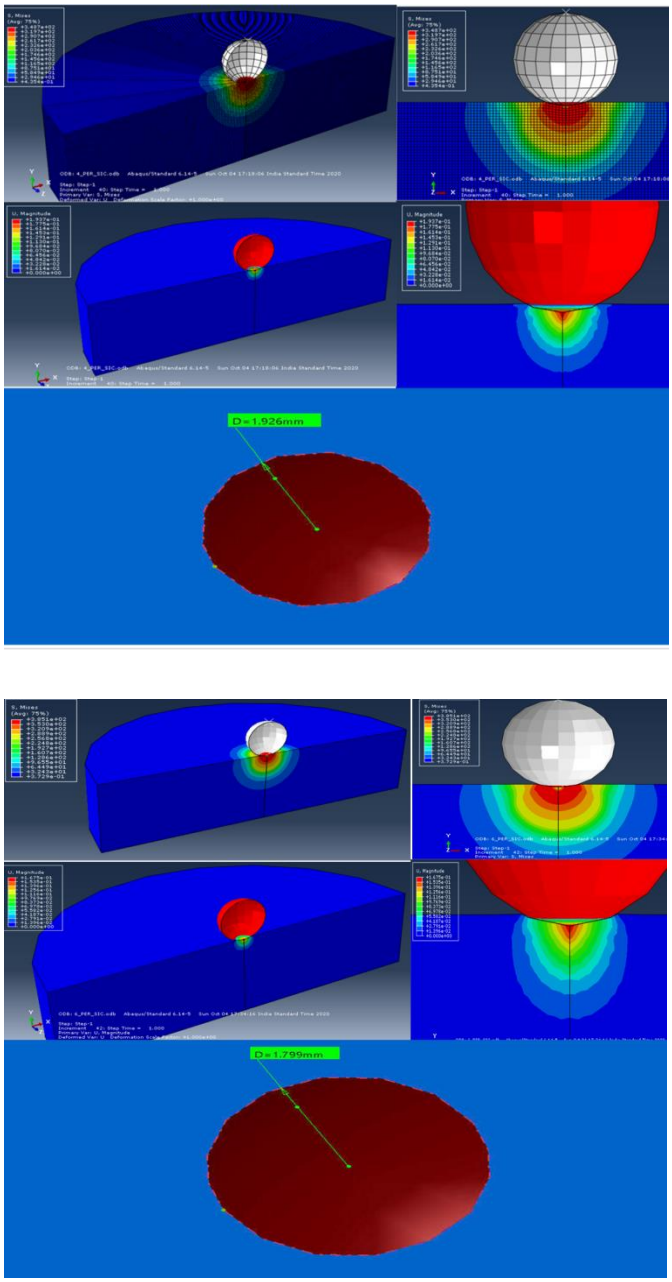


Fig.16 Stress, Deformation, Dia of Indentation

Figure 16 shows Stress values, Deformation and Dia of indentation of each specimens. And hardness of this material was calculated by using formulae given below.

$$BHN = \frac{2P}{\pi D(D - \sqrt{D^2 - d^2})}$$

Where BHN-Brinell Hardness No. in Kgf/mm2

P-Load in Kgf

D-Dia.of the Indenter (Steel Ball) in mm

d-depression Diameter in mm

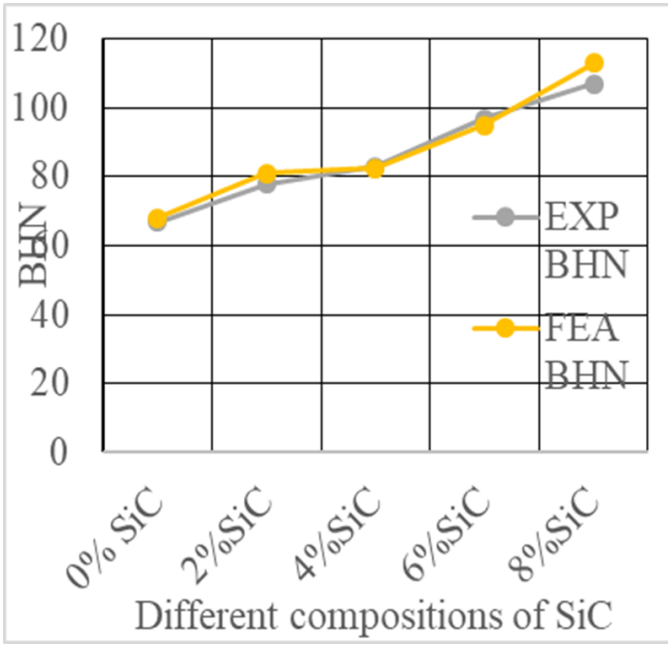
Depression diameter 'd' was estimated by knowing deformation of each specimen and by using CATIAV5.which are shown in the table.

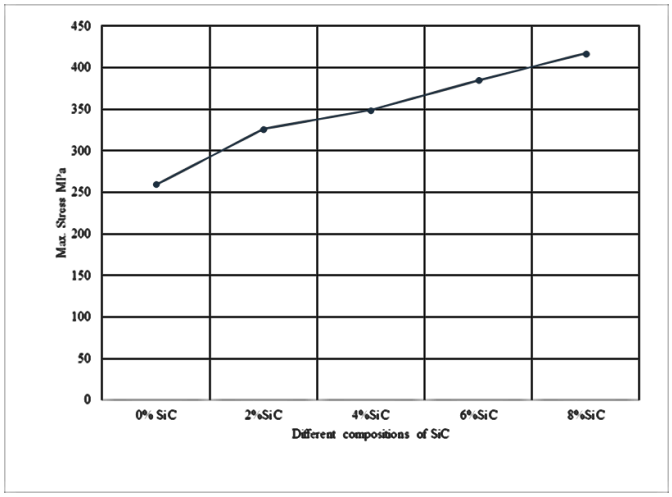
Wt%	0%	2%	4%	6%	8%
D(mm)	2.112	1.936	1.926	1.799	1.65

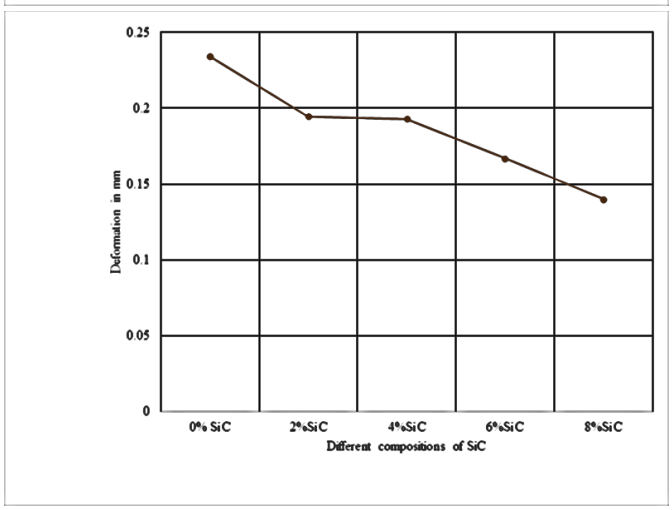
Table6.Depression diameters for all specimens

Compositions	EXP BHN *Kgf/mm²*	FEA BHN *Kgf/mm²*	Max.Stress Mpa	Deformation in mm
0% SiC	67	68	259.6	0.234
2%SiC	78	81	326.1	0.1945
4%SiC	83	82.54	348.7	0.193
6%SiC	97	95	385.1	0.167
8%SiC	107	113	417	0.14

Table 7. Comparisons of Results







From the above results, it is evident that Harness of the material was increased as the weight percentage of the SiC increased, and Deformation was decreased with increase in SiC weight percentage The maximum BHN was found to be 107.0Kgf/mm2 for 8%SiC. And FEM results and Experimental BHN values correlated with each other.

III.CONCLUSION

AA7075 reinforced with Nano SiC powder were fabricated with stir casting method. X ray diffraction test was carried out for the cast specimens. Hardness test was carried out for MMC's using BHN machine setup. and axissymetric FEM analysis was also done using ABAQUS.

The BHN values increased with increased SiC in both the cases in experimental and FE analysis.

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National Conference on Recent Advances in Mechanical Engineering and Materials
International Journal of Scientific Research in Mechanical and Materials Engineering
2021 IJSRMME | Volume 4, Issue 7 | ISSN : 2457-0435

Number Plate Detection and Recognition Using Python

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ABSTRACT

Over the past two decades, the automobile industry has made large strides in embodying technological advancements in its environment. We know see smarter vehicles on road that facilitates for efficient communication with humans. The automobile we own now is capable of providing statistical analysis of the usage associated with it. With technological concepts revolving around machine learning, artificial recognition and data analytics, we see that the advancements taking birth in the automobile sector is making it a very promising industry for automobile aspirants. To be a part of this technological marathon that is running across the world, we aim to deliver a simple yet efficient method of handling the data of numerous vehicles that enter and exit a particular location. The data that is linked to such a scenario is large and can be tedious to work with, if done manually. Adding to this, it does not provide a reliable source for working on, as data that is handled manually can be redundant and inaccurate. We use the python programming language that has shown to be the face of much advancement to solve this issue. With python and its packages, we can now detect the number on the number plate and store it in a database, that is easily accessible and functions can be performed on it with ease. A CCTV can aid us in capturing the front/back portion of the automobile where the number plate is attached to it. This image is now sent to an environment in python for image filtration techniques that processes the image to an extent where it filters out all the contours except our number plate. The string on the number plate can now be recognized by the software and is stored in a database with the additional information on when and what time the automobile entered/exited a particular location.

Keywords - Python, Penultimate, Utility, Display

I. INTRODUCTION

As we progress into the third decade of the 21st century, the need to comply with automation has given birth to a wide range of tech that makes human life at ease. But with this being the frontal part of a monumental background, we often do not seem to know how a particular function is processed. It comes with great power to understand technology as it opens up a wide array of possibilities for development. This array, more or less, circulates around the need for programming and developing problem solving skills. As we dig deep into concepts such as machine learning and artificial intelligence, we find there is a correlation amongst the two and can be logically devise it to be a subset of data analytics. We see various fields being automated with the concepts of machine learning and artificial intelligence. Let us take an example of home automation. It can be seen that anything that is electrically run, can be automated to make it a smart home. For example, a light bulb turns on when someone enters the room.

This can be achieved with the help of sensors. Automatic door locks can recognize when your cell phone is near or far and can lock doors accordingly. Such is the need for easing up complicated tasks. We use automobiles on a day to day basis and there can never be another substitute for it. As we progress into the future, development can take place only when there is sufficient data to work on. As aforementioned in the abstract, manual typing and handwritten tasks are often tedious and laborious. It becomes difficult to operate with such data as they need to be made computer- ready data for processing. With this, a logical conclusion to this problem, would be to automate any such tedious processes. Man-kind has almost reached the place, where a car no longer needs a driver to navigate himself to a destination. These techs are leaps and bounds ahead of what man could have imagined the industry of automobile to be at, 5-10 years back. As mentioned earlier, all this is only possible with the key factor of programming. Python in recent times has had great success in the programming environment with its ease of understanding and executing. In the coming chapters we will take a look at why python provides a great opportunity to learn and invest our time in, that can help us provide solutions to various problems in our day to day life.

II. LITERATURE REVIEW

The birth of this beautiful programming language took place in the late 1980's, and it we began seeing its implementation in the year 1989. Van Rossum, also known as the father of python, is python's primary author. Python 1.0 was initially launched in the year 1994. This saw of the rise of python's most prominent functions such as lambda, filter, reduce and map. Version 1.2 was later released in the year 1995. Python version 1.4 saw a great change in the functions it possessed. It now included key-word arguments and also supported complex numbers. Python 2.0 saw its rise in the early 2000's. It now possessed features like list comprehension, garbage collection, the with statement and many more. it also the coming together of python's types and classes into one hierarchy. It also saw the newly included warning feature that told the user, the existing feature is being removed in the upcoming versions. The support for python 2.0 saw its end in the early stages of 2020 and was put to bed with fixes for bugs and blockers that caused issues in the penultimate version of python 2. Python 3.0 also called as py3k announced its grand arrival on the 3rd of December in the year 2008. It is not backward compatible with python 2.0 and hence any script to run on python 3 which ran in python 2, had to be modified. Some of the major changes saw the print function being made available as a built-in function and did not require any imports. It also saw the replacement of the input statement i.e. raw_input () to just input (). In this project we use three important modules cv2, imutils and tesseract which we will look into much deeper in as we progress. These modules help in image recognition and processing that will help us with our project in obtaining data accurately. We will also take a step by step tour how this script is understood by the python interpreter and how the desired output is obtained.

III. OPERATING STEPS

Step 1 : Start.
Step 2 : Load captured image. Introduction
Step 3 : Resize image to standard size. (change width to 500)
Step 4 : Convert RGB image to grayscale.
Step 5 : Remove noise with bilateral filter. (preserve edge)
Step 6 : Find edges in the grayscale image.
Step 7 : Find contours based on the edges in the image.

Step 8 : Create a copy of the image to draw all the contours based on edges.
Step 9 : Sort all the contours and derive top 30 contours.
Step 10 : Loop over the contours to find a rectangular contour.
Step 11 : Draw the obtained contour on the image.
Step 12 : Crop the number plate from image.
Step 13 : Convert image to string.
Step 14 : Append the obtained string to a database with date and time of entry.
Step 15 : Finish.

IV. PYTHON MODULES USED

CV2

Open computer vision alias OpenCV is an open source python library, which within itself several algorithms for computer vision. This package can simply be described best, for its image and video processing capabilities. In this project we will focus mainly on its image processing functions. OpenCv accommodates a wide range of functionality including linear and non-linear filtration processes, image transformation with respect to geometry, inversion of colour, plotting of histograms and many more.
In this project we have used the following functions from the module CV2:

- Imread (): reads an image from the specified location.
- Imshow (): display the image mentioned as arguments
- find Contours (): finds all the contours in the given image.
- approxPolyDP (): Structures a closed and continues curve
- boundingRect (): Finds the co-ordinates of the given closed curve.
- drawContours (): embodies the contours into an image.
- Imwrite (): stores a new image with desired name.

Imutils

The imutils, short for I am utility function, in python is an open-source library that is made available for basic processing functions that can be applied on images. These functions include resizing, rotation, translation, displaying, sorting of contours, which is used in accordance with the OpenCv python module. To install this module in your python project run the following command on your terminal: Pip install imutils
The following functions were used from the module imutils:
Resize (): this function enables the user to resize any image accordingly, to obtain a desired image of the required dimensions. In accordance with the OpenCv python module, the imutils module helps in detecting contours, sorting the contours, and obtaining a closed rectangular contour which helps in the final step of getting a cropped image of the number plate.

Pytesseract

The pytesseract is short for the module called python source is which is another open source build available for python users. It is best described for its OCR prowess. In simple terms it can translate any text embodied in an image and return its user a string. The images can be of the format jpeg, jpg, bmp, tiff, png, gif and many others. This module holds the key factor in making this project what it is, as the text on the number plate in the image is transcript by the computer to append it to a database. Originally, it stood as a wrapper for Google's Optical character recognition engine.
To install this module in your python project run the following command on your terminal: Pip install pytesseract

The following functions were used from the module pytesseract:

- Pytesseract. Pytesseract. tesseract_cmd="": This tells the python interpreters to search for an executable file in the specified location that assigns it to the variable that will provide us with the OCR engine.
- Image_to_string() – this function, as the name suggests, runs through the image to find all the strings present in it and return the same.

This is the final step in our project after all the image filtration and processing has taken place. The filtered image is sent to the optical character recognition engine where the desired registration number of the given vehicle is obtained.

Time

The time module in python offers its users time related functions.

Pandas

The pandas library is one which is used vividly across any python platform. It provides functionality for data manipulation, in particular, numerical table and the series of time. It handles data exceptionally well and provides for a fast and flexible way for manipulation of data. Data structures including, lists, dictionaries and tuples can be converted to data frame using pandas.

V. CONCLUSION

Programming modules have set of collected packages and libraries which assist in complex data handling through pre-defined functions and help in the generation of new code without overly complication the process. The key is to minimize iteration and maximize efficiency via compact data code that ensures the most direct route to obtaining the output.

In this case the various stages of image recognition, scanning and conversion to numeric data to be input into a charted form, it is a directive of the fact that automation of this avenue is possible which indicates that further optimization is possible. With the world going digital, the scope for such software is the demand of the hour. One can argue that is might affect the grass-root level employees of any organization but the obvs counter to this will be the fact that this instead opens up better data entry handling process and instead of eliminating the manual labor all together it promotes it to the position of supervision and maintenance, this creating more sources of revenue.Practically speaking, one to one input of any data is prolonged task, hence software application is the required levels is a necessary part of digital transformation and is becoming an increasing investment within any origination's portfolio. Hence coding is setting the new precedent for efficiency especially with the changing trends of the industry.

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National Conference on Recent Advances in Mechanical Engineering and Materials
International Journal of Scientific Research in Mechanical and Materials Engineering
2021 IJSRMME | Volume 4, Issue 7 | ISSN : 2457-0435

Design and Fabrication of Multi-Side Pneumatic Modern Trailer

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ABSTRACT

This project work has been conceived having studied the difficulty in unloading the materials. Our survey in the regard in several automobile garages, revealed the facts that mostly some difficult methods were adopted in unloading the materials from the trailer.

Now the project has mainly concentrated on this difficulty, and hence a suitable arrangement has been designed. Such that the vehicles can be unloaded from the trailer in three axes without application of any impact force. By pressing the Direction control valve activated. The compressed air is goes to the pneumatic cylinder through valve. The ram of the pneumatic cylinder acts as a lifting the trailer cabin. The automobile engine drive is coupled to the compressor engine, so that it stores the compressed air when the vehicle running. This compressed air is used to activate the pneumatic cylinder, when the valve is activated.

I. INTRODUCTION

Automation can be achieved through computers, hydraulics, robotics, etc., of these sources, hydraulics form an attractive medium. Automation plays an important role in automobile. Nowadays almost all the automobile vehicle is being atomized in order to product the human being. The automobile vehicle is being atomized for the following reasons.

1. To achieve high safety
2. To reduce man power
3. To increase the efficiency of the vehicle
4. To reduce the work load
5. To reduce the fatigue of workers
6. To high responsibility
7. Less Maintenance cost

II. PNEUMATICS

The word 'pneumatic' comes from Greek and means breather wind. The word pneumatics is the study of air movement and its phenomena is derived from the word pneumatic. Today pneumatics is mainly understood to means the application of air as a working medium in industry especially the driving and controlling of machines and equipment Pneumatics has for some considerable time between used for carrying out the simplest mechanical tasks in more recent times has played a more important role in the development of pneumatic technology for automation. Pneumatic systems operate on a supply of compressed air which must be made available in sufficient quantity and at a pressure to suit the capacity of the system. When the pneumatic system is being adopted for the first time, however it wills indeed the necessary to deal with the question of

compressed air supply. The key part of any facility for supply of compressed air is by means using reciprocating compressor. A compressor is a machine that takes in air, gas at a certain pressure and delivered the air at a high pressure.

III. SELECTION OF PNEUMATICS

Mechanization is broadly defined as the replacement of manual effort by mechanical power. Pneumatic is an attractive medium for low cost mechanization particularly for sequential (or) repetitive operations. Many factories and plants already have a compressed air system, which is capable of providing the power (or) energy requirements and the control system (although equally pneumatic control systems may be economic and can be advantageously applied to other forms of power).

The main advantage of an all pneumatic system are usually economic and simplicity the latter reducing maintenance to a low level. It can also have outstanding advantages in terms of safety.

Production of Compressed Air

Pneumatic systems operate on a supply of compressed air, which must be made available in sufficient quantity and at a pressure to suit the capacity of the system. When pneumatic system is being adopted for the first time, however it wills indeed the necessary to deal with the question of compressed air supply.

The key part of any facility for supply of compressed air is by means using reciprocating compressor. A compressor is a machine that takes in air, gas at a certain pressure and delivered the air at a high pressure.

IV. LITERATURE REVIEW

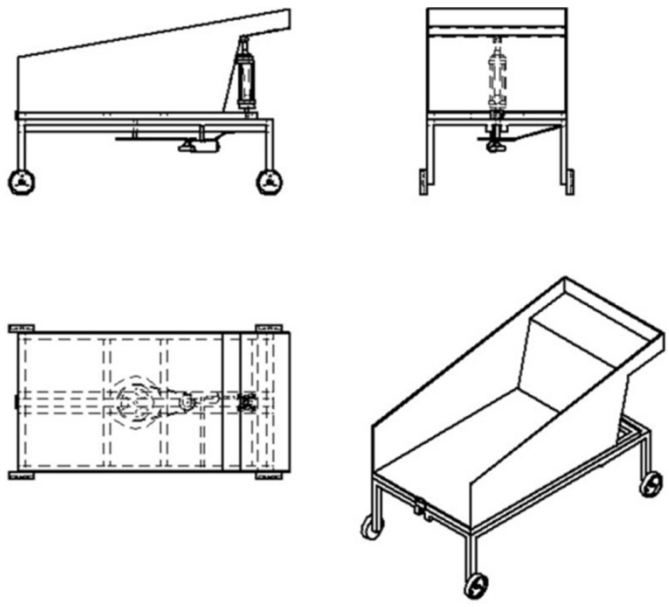
The trailer is thought to have been first conceived in the farms of late 19th century Western Europe. As early as 1905, the first motorized dumping vehicles were developed. The first motorized dump trucks in the United States were developed by small equipment companies such as Galion Buggy Co. Among many others around 1910. Such companies flourished during World War I due to massive wartime demand. Companies like Galion Buggy Co. continued to grow after the war by manufacturing a number of express bodies and some smaller dump bodies that could be easily installed on either stock or converted (heavy-duty suspension & drive train) Model T chassis prior to 1920. Galion and Wood Mfg., Co. built all of the dump bodies offered by Ford on their heavy-duty AA and BB chassis during the 1930s. Galion (now Galion Godwin Truck Body Co.) is the oldest known truck body manufacturer still in operation today.

The first known Canadian dump truck was developed in Saint John, New Brunswick when attached a dump box to a flatbed truck in 1920. The lifting device was attached to a cable that fed over sheave (pulley) mounted on a mast behind the cab. The cable was connected to the lower front end of the wooden dump box which was attached by a pivot at the back of the truck frame. The operator turned a crank to raise and lower the box. The first dump bed apparatus on a wheeled vehicle patented in Canada The present invention relates to trailer hitches, and, in particular, to a three-axis trailer hitch having an improved rotatable coupling about a longitudinal axis extending between the towing vehicle and the trailer. Trailer hitches providing mechanical coupling about three independent axes between a towing vehicle and a trailer are known in the art. One representative example is disclosed in U.S. Pat. No. 2,133,065. The trailer hitch disclosed in this patent employs a universal joint or coupling providing limited angular movement about a first or transverse axis and about a second or vertical axis. Rotatable coupling about a third or longitudinal axis is achieved by a longitudinally extending, internally tapered socket member attached to the universal joint. The internally tapered socket member receives the

forward end of an externally tapered pintle, the rear end portion of the pintle being securely connected to the trailer. The tapered forward end of the pint is rotatable secured within the internally tapered socket member by locking pin or bolt. The trailer is disconnected from the universal joint by manually releasing the sliding lock pin and withdrawing the tapered pin from its mating socket. It is a principal object of the present invention to provide a strong, safe, and simple trailer hitch having improved rotational coupling about the longitudinal axis extending between the towing vehicle and the trailer.

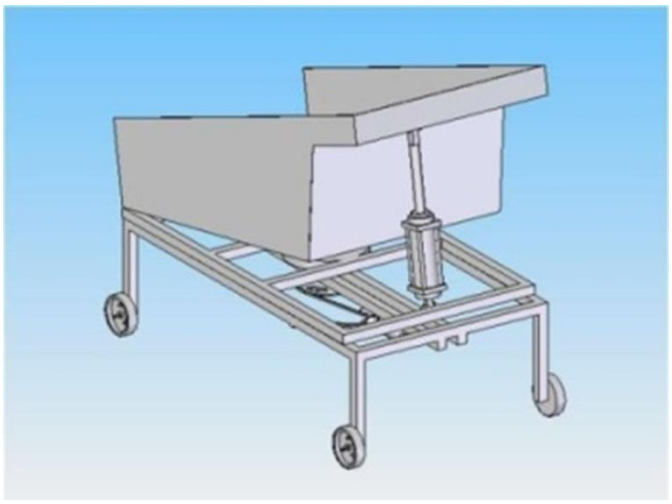
It is another object to provide a trailer hitch having a tightly coupled rotatable joint of low friction. An additional object is to provide a trailer hitch requiring a relatively simple adjustment to compensate for any wear of the abutting parts of the rotatable joint. The above objects of and the brief introduction to the present invention will be more fully understood, and further objects and advantages will become apparent, from a study of the following detailed description in connection with the drawings.

Orthogonal Views of multi-side pneumatic trailer

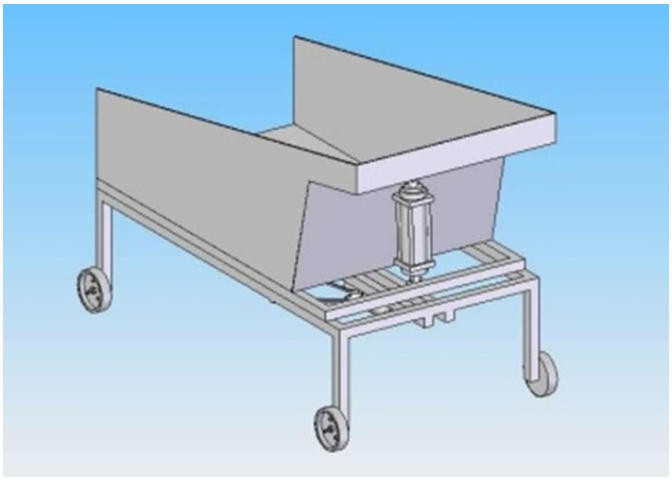


Orthogonal views of Tipper

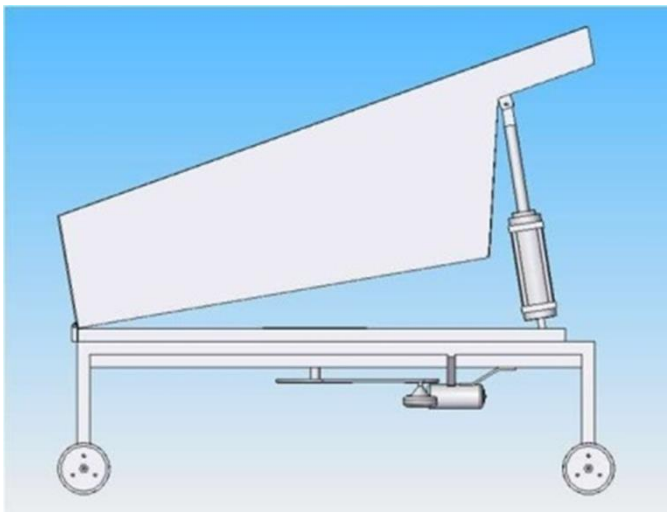
CAD Model



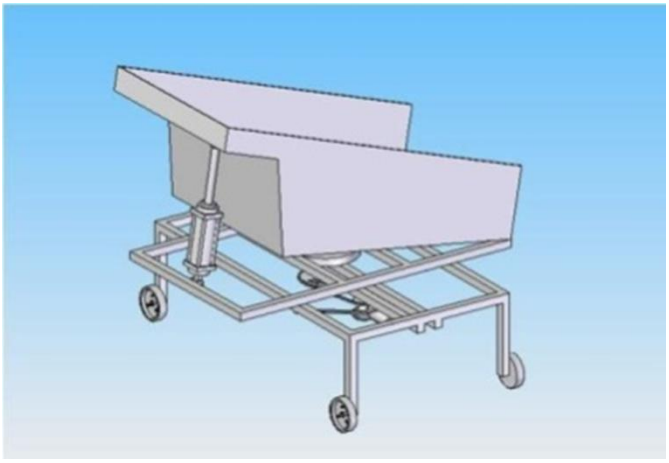
Assembled view of the trailer



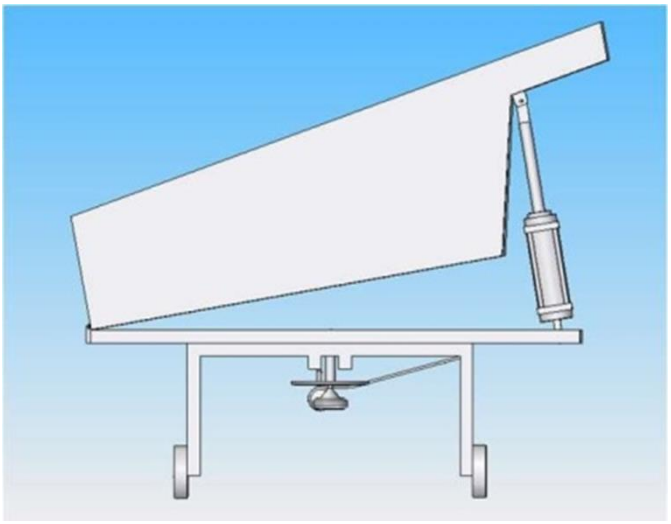
Tipping of trailer to the rear



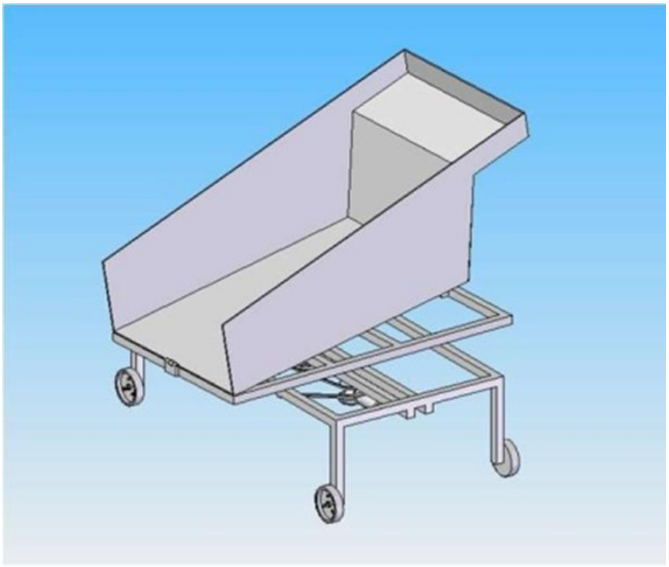
Left view of tipping the trailer to the rear



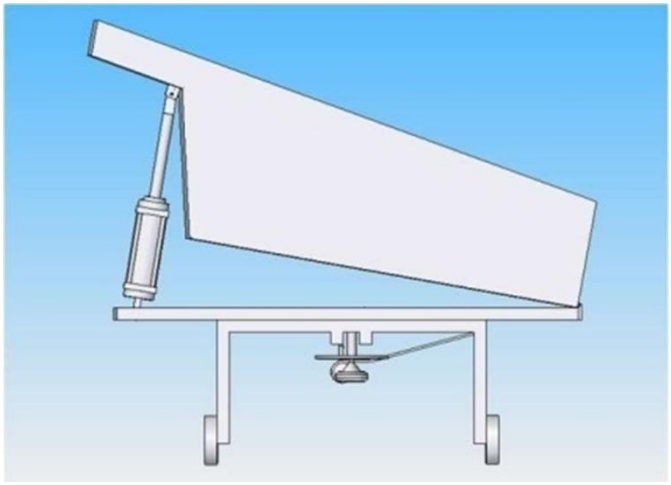
Tipping of trailer to the left of the truck



Rear view of tipping the trailer to the left



Tipping of trailer to the right of the truck



Rear view of tipping the trailer to the right

V. WORKING PRINCIPLE

- Since pneumatic circuit plays a vital role in this device, it is very necessary to explain the working of this circuit.
- Initially starting with air compresses, its function is to compress air from a low inlet pressure (usually atmospheric) to a higher pressure level. This is an accomplished by reducing the volume of the air.
- Air compressors are generally positive displacement units and are either of the reciprocating piston type or the rotary screw or rotary vane types. The air compressor used here is a typically small sized, two-stage compressor unit. It also consists of a compressed air tank, electric rotor and pulley drive, pressure controls and instruments for quick hook up and use. The compressor is driver by a 1 HP motor and designed to operate in 10 – 100 PSI range. If the pressure exceeds the designed pressure of the receiver a release value provided releases the excesses air and thus stays a head of any hazards to take place.
- Then having a pressure regulator where the desired pressure to the operated is set. Here a variable pressure regulator is adopted. Through a variety of direction control value are available, a hand operated spool value with detent is applied.

- The spool value used here is 5 ports, 3 positions. There are two exhaust ports, two outlet ports and one inlet port. In two extreme positions only the directions can be changed while the Centro ore is a neutral position and no physical changes are incurred. The 2 outlet ports are connected to an actuator (Cylinder). The pneumatic activates is a double acting, single rod cylinder. The cylinder output is coupled to further purpose. The piston end has an air horning effect to prevent sudden thrust at extreme ends.
- The compressed air from the compressor reaches the direction control valve. The direction control valve changes the direction of flow according to the valve position handle.
- The compressed air pass through the direction control valve and it is admitted into the front end of the cylinder block. The air pushes the piston for the lifting stroke. At the end of the lifting stroke air from the valve reaches the rear end of the cylinder block. The pressure remains the same but the area is less due to the presence of piston rod. This exerts greater pressure on the piston, pushing it at a faster rate thus enabling faster return stroke.
- The stroke length of the piston can be changed by making suitable adjustment in the hand liver valve operating position.

Advantages:

- It requires simple maintenance cares
- Checking and cleaning are easy, because of the main parts are screwed.
- Handling is easy.
- Manual power not required
- Repairing is easy.
- Replacement of parts is easy.

Disadvantages:

- Initial cost is high.
- Separate air tank or compressor is required

Application:

All hydraulic and pneumatic dipper applications

VI. CONCLUSION

This project work has provided us an excellent opportunity and experience, to use our limited knowledge. We feel that the project work is a good solution to bridge the gates between institution and industries.

The **"MULTI-SIDE PNEUMATIC MODERN TRAILER"** is working with satisfactory conditions. As for this trailer is concerned in India, single piston arrangement is the most commonly used. Instead, with the same Piston arrangement available, repositioning the system with the help of the spur gears meshed normal to each other, the trailer can be lifted in the other two sides just by changing the position with the help of a motor connected with the battery.

Thus we have developed a **"MULTI-SIDE PNEUMATIC MODERN TRAILER"** which helps to know how to achieve low cost automation. The operating procedure of this system is very simple. By using innovative techniques, this system can be modified and developed based on the human need in our day to day life.

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THE INTERNATIONAL OPEN ACCESS PUBLISHER

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IJSAMME

National Conference on Recent Advances in Mechanical Engineering and Materials NCRAMEM-2020

Organised by

Department of Mechanical Engineering,
East Point College of Engineering And
Technology, Avalahalli, Bengaluru, Karnataka, India

Publisher

Technoscience Academy

Website : www.technoscienceacademy.com
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