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## Design and Analysis of Casted Mecanum Wheel

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**Abstract**— In this study, an attempt has been made to design and manufacture the mecanum wheels by using aluminium alloys. Sand casting is adopted as the fabrication technique. The study was also extended to understand the load carrying capacity of the mecanum wheel using standard compression test of universal testing machine. It was observed that single wheel can withstand maximum load of 340 Kg. It is also observed the hardness number up to 170 BHN (Brinell hardness number) was achieved through the casted aluminium product.

**Keywords**— Mecanum Wheel, Manufacturing, Universal Testing Machine, Brinell hardness number.

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### I. INTRODUCTION

Mecanum wheels are complex omni-directional wheels, which includes complicated engineering designs. There has been considerable interest in recent years [1-10] in enhancing the design parameters of the wheel as it involves several drawbacks like bumps due to rollers, material grade selection etc. The mecanum-style drive base uses 4 wheels, including 2 right wheels and 2 left wheels. One right and left is on each side of the robot, each wheel is driven independently. Mecanum wheel consist of series of rollers which are at 45 degree to the circumference of the wheel and 45 degree to the plane of the wheel [1].this design of wheel allows for in- place rotation which prevents ground friction to a great extent and results into low driving torque. Some times mecanum wheels are also called as the ilon wheel after its swedish inventor, bengtilon, who came up with the idea in 1973 [2].since then considerable changes have been observed in the basic design of wheels. Andy marks [3], leading manufacturing company based in United States produces different size of wheels with different load carrying capacities. Currently, rubber rollers are crammed in between 2 steel plates and these plates are then riveted and bolted to two interior cone-shaped aluminium pieces, which forms the interior hub of the wheel.

An attempt has been made to manufacture the mecanum wheels by aluminium alloys through sand casting technique. The basic intend was to design and fabricate the wheels which can withstand more loads compared to the available mecanum wheel in market of same size.

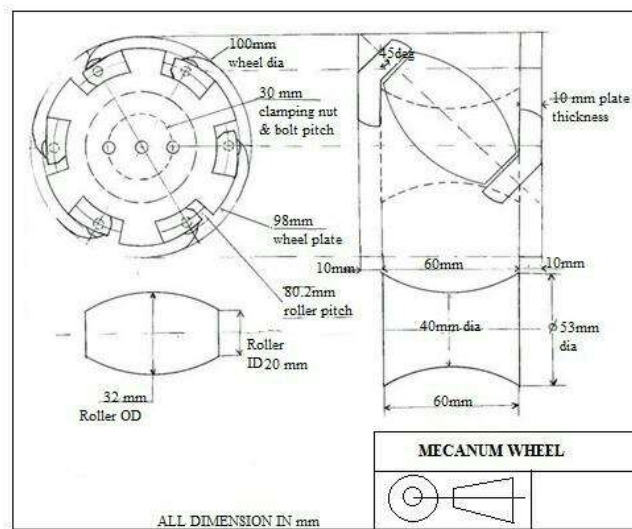
### II. DESIGN AND CONSTRUCTION

After studying the conceptual design [4, 5] and results of prototype model, it was observed that the wheel with 6 rollers would give more stability to the product. The specification of the mecanum wheels are listed in Table 1. The dimensions of the wheel were carefully chosen with proper engineering reasoning to adopt the design changes in the current model. Standard text and data handbooks [6, 7] were used for the design and analysis purposes.

**Table 1: Mecanum wheel specifications.**

Outer diameter	100mm
Roller diameter	32mm
Angle of the roller with respect to wheel surface	45 degrees
Width of wheel	80mm
Diameter of inner support D	53mm
Diameter of inner support d	40mm

Figure 1 shows a two-dimensional drawing of mecanum wheel with all specifications, from which it can be seen that the wheel design is completely different from the previously available once.



**Figure 1: Two dimensional view of Mecanum wheel**

After repetitive analysis the final design was manufactured by aluminium alloy. Aluminium alloys were selected to obtain good weight to strength ratio. The whole product was divided in to three parts two side plates, one supporter at the middle and nylon wheels at the periphery. Side plates as well as the middle supporter were casted using sand casting method. Figure 2 shows the sand moulding of side plate used for casting.

Composition characteristics of casted aluminium alloys are listed in Table 2. From Table it is evident that the material selected is aluminium-silicon alloy i.e. aluminium alloy.



**Figure 2: Sand molding of the mecanum wheel**

Table 2: Casted mecanum wheel composition.

Material	Al	Si	Fe	Mn	Ti	Zn	Others
% Composition	86.476	12.990	0.258	0.114	0.027	0.024	0.11

The machining of the wheel is done on the manually operated drilling machine with an additional attachment to it which forms the 4th and 5th axis for the drilling machine. Figure 3 shows the machine during the operation.



Figure 3: A manually operated drilling machine with attachment.

Figure 4 shows the completely assembled mecanum wheel, where in the nylon wheels are assembled by using the bearings and the standard nut and bolts. The size and shape of the nylon wheels were kept consistent by using the developed the tools to cut the desired shapes.



Figure 4: Assembled mecanum wheel.

### III. RESULTS AND ANALYSIS

Tests like compression test on universal testing machine and hardness test on Brinell hardness testing machine were carried out on the mecanum wheel. Figure 5 shows the deformed wheel after the compression test. It is evident that the neither the nylon wheel nor the nut have deformed under the loading. Load Vs Cross Head Travel (CHT) data are plotted in Figure 6 and it is observed that the newly designed mecanum wheel can withstand maximum load of up to 340 Kg.



Figure 5: deformation of the wheel after compression

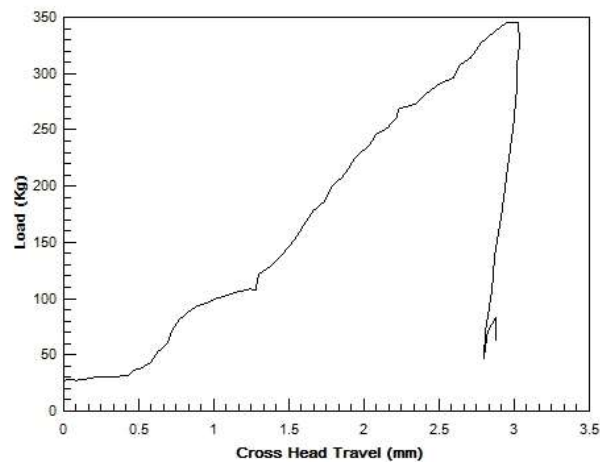


Figure 6: Graph showing the Load vs. CHT

## CONCLUSIONS

Mecanum wheel have great advantages over conventional (non-holonomic) platforms, without car-like Ackerman steering or differential drive system, for moving in tight areas. They can crab sideways, turn on the spot, and follow complex trajectories. These robots are capable of easily performing tasks in environments with static and dynamic obstacles and narrow aisles. Such environments are commonly found in factory workshop offices, warehouses, hospitals, etc. The development of a mecanum wheel was pursued to further prove the effectiveness of this type of architecture and to add a ground vehicle platform that is capable of exceptional maneuverability.

## Acknowledgement

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