



Design of Mecanum Wheel

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ABSTRACT

In this essay, we examine studies on the design of multidirectional vehicles that use Mecanum wheels as a key component. In terms of mobility in crowded areas, multidirectional vehicles have many advantages over conventional designs like differential drive. In areas crowded with static and/or moving obstacles and small aisles, such those frequently seen in factories, warehouses, offices, and hospitals, a multi-directional vehicle could carry out crucial functions. Mecanum wheel installed Mecanum have undergone a number of designs in recent years in an effort to enhance their multidirectional maneuverability and practical applications. The expansion of these features comes at the expense of greater mechanical complexity and control mechanism complexity. Mecanum wheel systems operate similarly to conventional wheel systems by rotating each wheel individually in a single direction.

Keywords: Mecanum, Multi-directional, automobile.

1. Introduction

Mecanum Wheel or Ilon Wheel is a typical omni-directional wheel design. The Mecanum wheel operates on the premise of a centre wheel with a number of breakers arranged at an angle around the wheel's fringe. The angled supplemental comber converts a portion of the force in the rotational direction of the wheel to force normal to the wheel directional. Depending on the direction and speed of each individual wheel, the performing combination of all these forces provides a total force vector in any asked direction, allowing the platform to move freely in the direction of the performing force vector without changing the direction of the wheel. This design can only serve on a flat work face. Using four Mecanum buses allows a vehicle to drive in all directions without the need for a conventional steering system. Because the Mecanum wheel has only one comber with a single point of ground contact at any given moment, slippage is a regular issue. The Mecanum wheel's dynamics allow it to generate force vectors in both the x and y directions despite only being propelled in the y direction. By placing four Mecanum buses, one at each corner of the lattice (two imaged dyads), net forces in the x, y, and rotational directions can be created. One disadvantage of this method is that it requires four variables to regulate three degrees of freedom. The system is said to be in this case.

2. Literature Survey

The **Mecanum wheel** is a design for a wheel which can move a vehicle in any direction. It is sometimes called the Ilon wheel after its inventor, Bengt Erland Ilon, who came up with the idea in when he was an engineer with the Swedish company Mecanum AB. The US-Patent was filled on the 13 November 1972.

This is a conventional wheel with a series of breakers mounted around it. These breakers generally have their separate axes of gyration 45° to the aeroplane of the wheel and 45° to a line through the center of the comber parallel to the axis of gyration of the wheel. A typical configuration is his four-wheeled interpretation of the omnidirectional mobile robot URANUS (pictured), or a wheelchair with Mecanum bus(analogous to the picture). By interspersing the bus with left and right rotating breakers so that each wheel exerts a force nearly vertical to the slant of the wheelbase, the vehicle is stable and can be controlled at any asked speed and direction. You can move and turn in any direction. Gyration of each wheel. Moving all four wheels in the same direction will move forward or backward, rotating one wheel in the contrary direction to the contrary wheel will turn the vehicle, and rotating the bus transversely in the contrary direction will turn the vehicle. On the contrary side, the other slant causes side movement. The combination of these wheel movements allows the vehicle to move in any direction with arbitrary gyration (or no gyration at each). Before starting work, we reviewed a number of exploration papers showing that it's a delicate task for the material handling assiduity due to the numerous factors associated with Mecanum wheel..

3. Methodology

Direction of Movement	Wheel Actuation
Forward	All wheels forward same speed
Reverse	All wheels backward same speed
Right shift	Wheels 1 , 4 forward;2 , 3 backward
Left shift	Wheels 2 , 3 forward;1 , 4 backward
CW Turn	Wheel 1 , 3 forward; 2 , 4 backward
CCW Turn	Wheel 2 , 4 forward; 1 , 3 backward

Table no. 1

By applying force at one angle to the robot, we can change the magnitude of the force vector and achieve translational control of the robot. By applying force at an angle to the robot, we can change the size of the force vector and achieve translational control of the robot. In unprofessional terms, the robot can move in any direction while holding the front of the robot in a steady compass direction.

4. Calculation

4.1 EN 10083 C45 steel carbon steel

Physico-chemical test items for C45 steel sheets, which are products of our factory, include tensile test, hardness test, impact test, flatness test, and chemical composition analysis. C20 and C45 steel pipes are produced by cold drawing. C45 is a medium carbon steel used when higher strength and hardness than in the rolled state is required. Outstanding dimensional accuracy, straightness and concentricity minimize wear in high-speed applications. Turning, Grinding, Polishing.

Soft annealing:

Heat to 680-710°C and cool slowly in the oven. This achieves a maximum Brinell hardness of 207.

Normalize:

Normalized temperature: 840-880°C/air.

Curing:

It is hardened at a temperature of 820-860 °C and then quenched with water or oil.

Tempering:

Tempering temperature: 550-660°C/air.

C45 steel plate, EN 10083 C45 steel plate, according to the EN 10083 standard,

C45 steel plate can be considered as high carbon steel.

C45 steel sheet is mainly carbon steel and EN 10083

C45 steel sheet is for quenching and tempering. Technical delivery terms for unalloyed steel.

These steels are intended for general technical purposes.

Chemical Composition of EN C45 steel

C45 EN 10083-2 Number: 1.0503	Comparison of steel grades	
	JIS G 4051	S 45 C
	DIN 17200	C 45
	NFA 33-101	AF65-C 45
	UNI 7846	C 45
	BS 970	070 M 46
	UNE 36011	C 45 k
	SAE J 403-AISI	1042/1045

Table no.2

Mechanical Properties of EN C45 steel

Grade	C(%)min-max	Si(%)min-max	Mn(%)min-max	P(%)max	S(%)max	Cr(%)min-max
C45	0.42-0.50	0.15-0.35	0.50-0.80	0.025	0.025	0.20-0.40

Table no.3

Properties of steel C45 (1.0503) Properties of steel C45 (1.0503)

Welding capacity:Due to its medium-high carbon content, it can be welded with some care.

Hardenability:Due to its low hardenability against water and oil, it is suitable for surface hardening, and this steel grade has a highhardened shell hardness.

Why did we choose mild steel C-45 for our project?

- Easily available in all sections.
- Welding ability
- Machinability
- Cutting ability
- Great for all other metals.

4.2 Wheel Calculation

Material = C 45 (mild steel)

Take factor of safety 2

$$\sigma_t = \sigma_b = 540/\text{fos} = 270\text{N/mm}^2$$

$$\sigma_s = 0.5 \sigma_t$$

$$= 0.5 \times 270$$

$$= 135 \text{ N/mm}^2$$

Let the total weight (P) of our machine be 40 kg, now this 40 kg weight is kept on four angles, so it may fail under bending.

$$P = 40 \text{ kg.}$$

$$P = 40 \times 9.8 = 392 \text{ N.}$$

$$L = 610 \text{ mm.}$$

$$M = WL/4 = 392 \times 610/4$$

$$= 59780 \text{ N-mm}$$

$$Z = B^3/6 - b^4/(6 \times B)$$

$$= 25^3/6 - 22^4/(6 \times 25)$$

$$Z = 1042 \text{ mm}^3$$

$$= M/Z = 59780/1042 = 57.37 \text{ N/mm}^2$$

As induced bending stress is less than allowable bending stress design is safe.

Hence, selecting weld rod size = 3.2mm

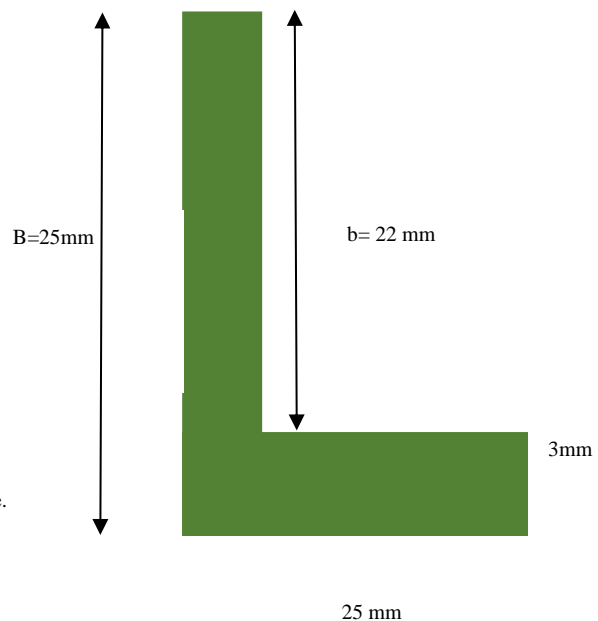


Fig no .1

Area of Weld = 0.707 x Weld Size x L

= 0.707 x 3.2 x 25

= 56.56 mm²

Stress induced = Force Exerted / Area of Weld

21 = F / 56.56

F= 1187.76 N = 121.07 kg

Maximum Allowable Stress for Welded Joints = 21 N/mm²

The total weight of machine is not more than 20kg, this weight is distributed on all four wheels. So weight on each wheel(W) is 5 kg.

Power of motor is 12 V, 15 watt and 20 rpm.

Figure Motor

W=5 kg= 5 x 9.8 = 50N say

M= FxL

M= 50x25=1250 N-mm

P=2πNT/60

T= 15 x 60/2xπx20

T= 7.16 N-m= 7162 N-mm

T_e= √ (M²+T²) = √1250²+7162²

= √1562500+51294244

= √ 52.86 x10⁶

T_e=7270.26 = 7.27 x 10³N-mm

T_e=π/16 xσ_sxd³

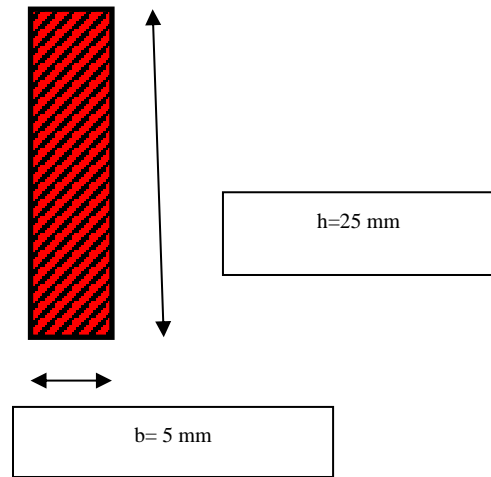


Fig no .2

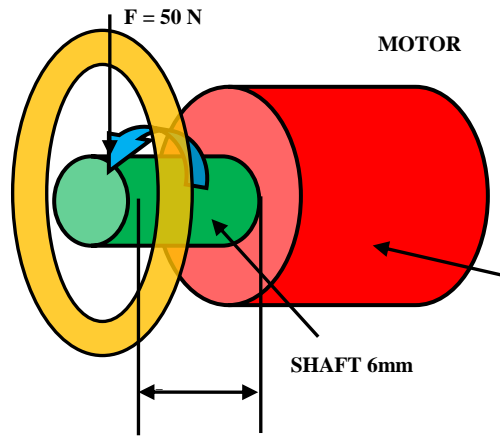
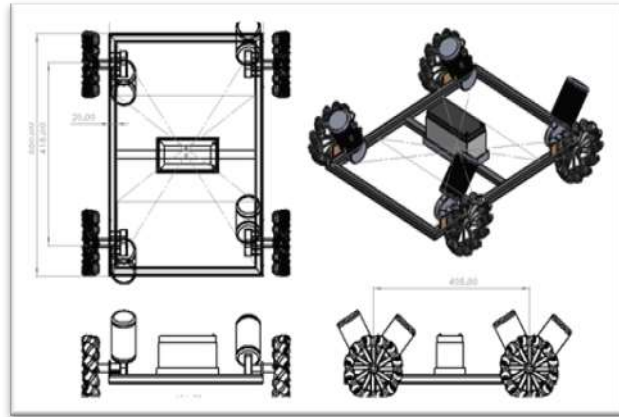


Fig no. 3

5. Design

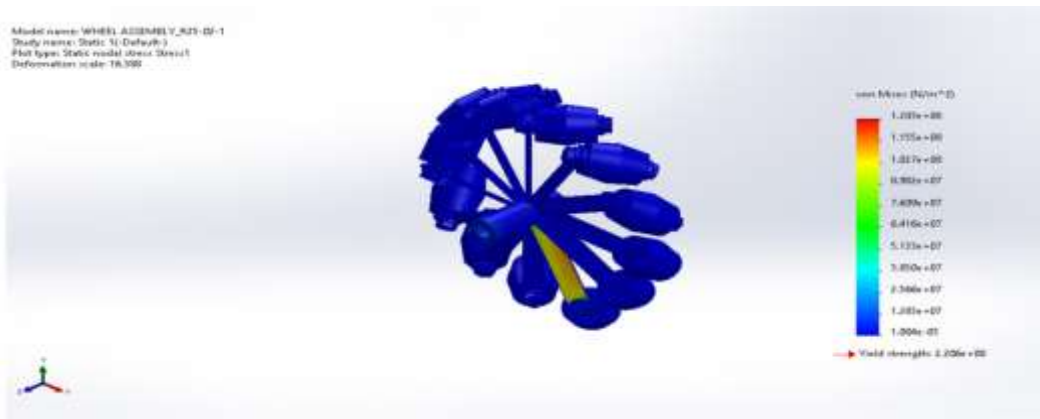


CAD Fig no. 1

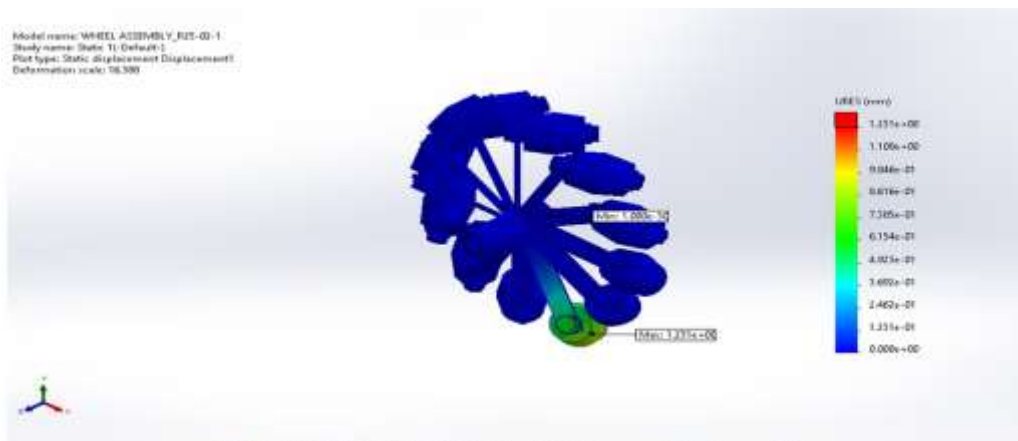


CAD Fig no. 2

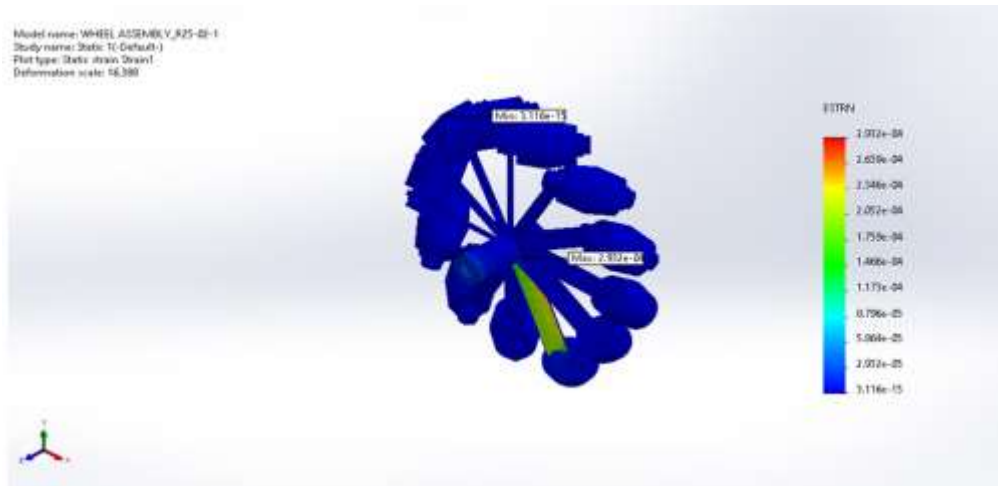
6. Analysis



Static nodal stress Fig no. 5



Static displacement Fig no. 6



Static strain

Fig no. 7

7. Conclusion

1. Mecanum wheels are wheels that allow the vehicle to move in any direction.
2. Compared to skid steer loaders, Mecanum wheels have the advantage of no additional friction when turning. Tracked and skid steer vehicles use similar turning methods.
3. However, these vehicles typically drag on the ground when turning and can cause serious damage on soft or delicate surfaces. Also, the ground friction increases when turning, so a high torque motor is required to overcome the friction.
4. By comparison, the Mecanum wheel design allows for high-speed rolling with minimal ground friction and low torque. Mecanum wheels are simpler and potentially more reliable than the Dodge/Club system.
5. The downside is weight (commercial bikes are ridiculously heavy) and cost. With a specific tread material, smaller contact area and 45% roll-off, traction is around 65-70% of a normal wheel.

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