

I'll assume that you want a traction-limited drivetrain. That is, the motors should be able to exert enough force to slip the wheels.

First, let's calculate the force between the carpet and the wheels due to friction. The robot weighs 150 lbs and there are four wheels. We'll denote the coefficient of static friction as  $\mu$ . For one wheel:

$$F = \frac{150 \text{ lb}}{4} \cdot \mu$$

For a mecanum wheel, the torque required to produce a given force is given by

$$\tau = \frac{1}{\sqrt{2}} \cdot F \cdot r$$

where  $r$  is the radius of the wheel. Note that for regular wheels, the torque is instead  $\tau = F \cdot r$ . Putting these equations together, we can write,

$$\tau = \frac{1}{\sqrt{2}} \cdot 38 \text{ lb} \cdot \mu \cdot r$$

Inserting the numbers you gave ( $\mu = 0.9$  and  $r = 4 \text{ in}$ ), we get

$$\tau = \frac{1}{\sqrt{2}} \cdot 38 \text{ lb} \cdot 0.9 \cdot 4 = 193 \text{ in} \cdot \text{lbs} = 21.8 \text{ N} \cdot \text{m}$$

and

$$\tau = \frac{1}{\sqrt{2}} \cdot 38 \text{ lb} \cdot 0.6 \cdot 4 = 129 \text{ in} \cdot \text{lbs} = 14.6 \text{ N} \cdot \text{m}$$

The CIMple box has a 12:56 gear ratio, and a single CIM motor has stall torque of 2.42 Nm. You have a 39:42 reduction, so the maximum torque on a wheel is

$$\tau_{stall} = 2.42 \text{ N} \cdot \text{m} \cdot \frac{56}{12} \cdot \frac{42}{39} = 12.2 \text{ N} \cdot \text{m}$$

This is much less, than the

Conversely, we can calculate the approximate speed of the robot. If you were running the CIM near maximum efficiency, the RPM would be between 70 and 80% of free speed, say 3600 RPM. The angular velocity of the wheel is

$$\omega_{wheel} = 3600 \frac{\text{rev}}{\text{min}} \cdot \frac{12}{56} \cdot \frac{39}{42} = 716 \frac{\text{rev}}{\text{min}}$$

which means the robot's velocity is

$$v_{robot} = 716 \frac{\text{rev}}{\text{min}} \cdot \frac{1}{60} \frac{\text{min}}{\text{sec}} \cdot \frac{8 \cdot \pi}{12} \frac{\text{feet}}{\text{rev}} = 25 \frac{\text{feet}}{\text{sec}}$$

which is clearly way too fast.

Working backwards, if you want a particular torque on the wheel, you can find the sprocket ratio:

$$r_{required} = \frac{\tau}{2.42 \text{ N} \cdot \text{m} \cdot \frac{56}{12}}$$