TIRE

Best tire used for solar vehicle in world solar challenge "**Bridgestone Ecopia Solar Race Tire**".

Tire specification:

- **Nominal diameter:** 19.09 in (≈485 mm)
- **Wheel diameter:** 14 in (≈356 mm)
- **Section width:** 2.48 in (≈63 mm)
- **Weight:** 0.73 kg
- **Inflation pressure:** 113 psi (≈7.8 bar)
- **Static load capacity:** 200 kg
- **Rolling resistance coefficient:** 0.0045 – 0.005 (at 100 km/h)
- **TIRE ONLY → ₹20K–₹33K & custom rim can cost around 10-15k.**
  So, around 30-40k per tire

NOTE

- Bridgestone **does not sell** the Ecopia Solar Race Tire (the 14" ologic version) to the general public or even to most commercial entities.
- These tires are manufactured in limited batches specifically **for teams competing** in the **Bridgestone World Solar Challenge (BWSC)** or the **American Solar Challenge (ASC)**
- they are supplied to teams **as part of a sponsorship agreement** or a specific racing allocation.

"So right now we can't have them for our vehicle"

Factor affecting tire performance:

- tire **radius**
- tire **width**
- tire **load capacity**
- tire **friction coefficient (μ)**
- tire **rolling resistance**
- tire **contact patch**

Parameter	14" wheel	16" wheel (Selected)	18" wheel
Rolling resistance	100%	~96–98% (2–4% lower)	~94–96% (4–6% lower)
Rotational inertia	100%	~130%	~165%
Acceleration capability	100%	~92–95%	~80–85%
Obstacle crossing ability	100%	~115%	~130%
Packaging difficulty	100%	~110%	~140%

MRF Zapper-FS 80/100-17 46P TUBELESS

Basic Specifications

Parameter	Specification
Tyre Size	**80/100-17**
Tyre Type	**Tubeless**
Construction	**Bias-ply / Bias-belt**
Rim Diameter	**17 inch**
Section Width	**80 mm**
Aspect Ratio	**100**
Load Index	**46**
Speed Rating	**P**
Material	Rubber compound
Typical Use	Front tyre for motorcycles

Parameter	Value
Vehicle weight	**300 kg**
Speed	**80 km/h**
Rolling resistance force	**35 N**
Aerodynamic drag force	**217 N**
Power for rolling resistance	**0.78 kW**
Power for drag	**4.82 kW**
Total wheel power	**5.6 kW**
Required engine power	**≈6.6 kW (8.8 HP)**

Michelin City Pro 80/100-17 Tubeless

Basic Specifications

Parameter	Specification
Tyre Size	**80/100-17**
Tyre Type	**Tubeless**
Construction	**Bias / Nylon**
Rim Diameter	**17 inch**
Section Width	**80 mm**
Aspect Ratio	**100**
Load Index	**46–53 depending on version**
Speed Rating	**P (150 km/h)**
Material	Rubber compound
Typical Use	Front / Rear motorcycle tyre

Parameter	Value
Vehicle weight	**300 kg**
Speed	**80 km/h**
Rolling resistance force	**29 N**
Aerodynamic drag force	**217 N**
Power for rolling resistance	**0.64 kW**
Power for drag	**4.82 kW**
Total wheel power	**5.46 kW**
Required engine power	**≈6.4 kW (8.6 HP)**

Michelin City Extra 80/100-17 Tubeless

Basic Specifications

Parameter	Specification
Tyre Size	**80/100-17**
Tyre Type	**Tubeless**
Construction	**Bias / Nylon reinforced**
Rim Diameter	**17 inch**
Section Width	**80 mm**
Aspect Ratio	**100**
Load Index	**46–53 depending on version**
Speed Rating	**P (150 km/h)**
Material	Rubber compound

Parameter	Value
Vehicle weight	**300 kg**
Speed	**80 km/h**
Rolling resistance force	**26 N**
Aerodynamic drag force	**217 N**
Power for rolling resistance	**0.58 kW**
Power for drag	**4.82 kW**
Total wheel power	**5.40 kW**
Required engine power	**≈6.35 kW (8.5 HP)**

Comparison (MRF vs Michelin)

Parameter	MRF Zapper-FS	Michelin City Pro	Michelin City Extra
Friction coefficient	~0.7	~0.8	~0.82
Rolling resistance coeff	0.012	0.010	**0.009**
Rolling resistance force	35 N	29 N	**26 N**
Rolling resistance power @80 km/h	0.78 kW	0.64 kW	**0.58 kW**
Total wheel power	5.6 kW	5.46 kW	**5.40 kW**

SUMMARY:

Michelin City Extra 80/100-17 Tubeless

Michelin City Extra is a reinforced bias-ply motorcycle tire designed for commuter bikes. It has 80 mm width, 100 aspect ratio, 17-inch rim, load index 46–53, and speed rating P (150 km/h).

For a 300 kg vehicle at 80 km/h, assuming rolling resistance coefficient ≈ 0.009:

- Rolling resistance force ≈ 26 N
- Rolling resistance power ≈ 0.58 kW
- Aerodynamic drag power ≈ 4.82 kW
- Total wheel power ≈ 5.40 kW
- Required engine power ≈ 6.35 kW (≈8.5 HP)

Typical price in India: ₹1600–₹1900.

RIMS

Material	Approx cost per rim
Steel	₹1.5k – ₹3k
Aluminium alloy	₹3k – ₹8k
Magnesium alloy	₹40k – ₹1.5L
Carbon fibre	₹1.5L – ₹3.5L

Michelin City Extra 80/100-17

Rim: 17 × 1.85 aluminum alloy

Weight: ~3.5 kg

Cost: ₹4.5k – ₹6k

FINAL TIRE

- **Tires**: Michelin City Extra 80/100-17
- Quantity: 2 tires + 1 spare
- Total tire budget: ₹4k–₹6k
- **Rim:** 17 × 1.85 aluminum alloy rim
- Quantity**: 2*** ₹5k each

Full wheel budget

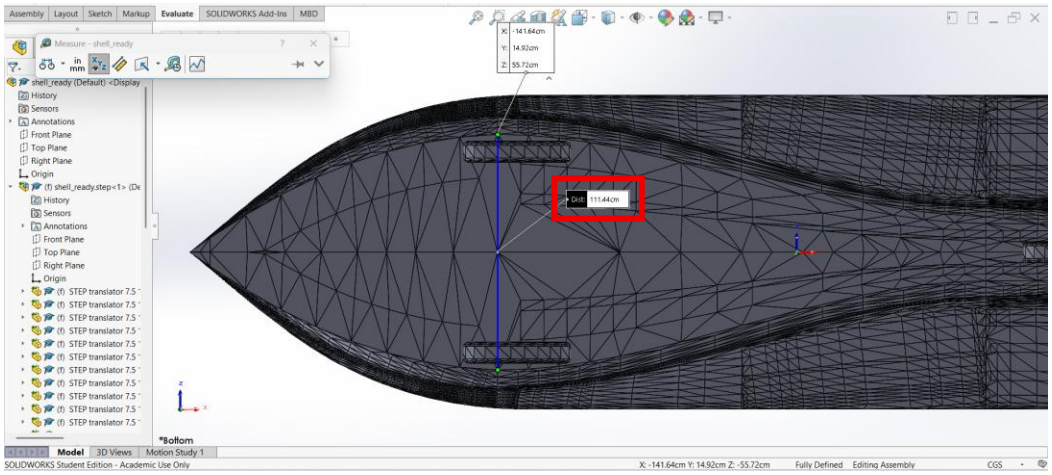
Item	Cost
2 tyres	₹4,000
2 rims	₹10,000
Total	≈ **₹14,000**

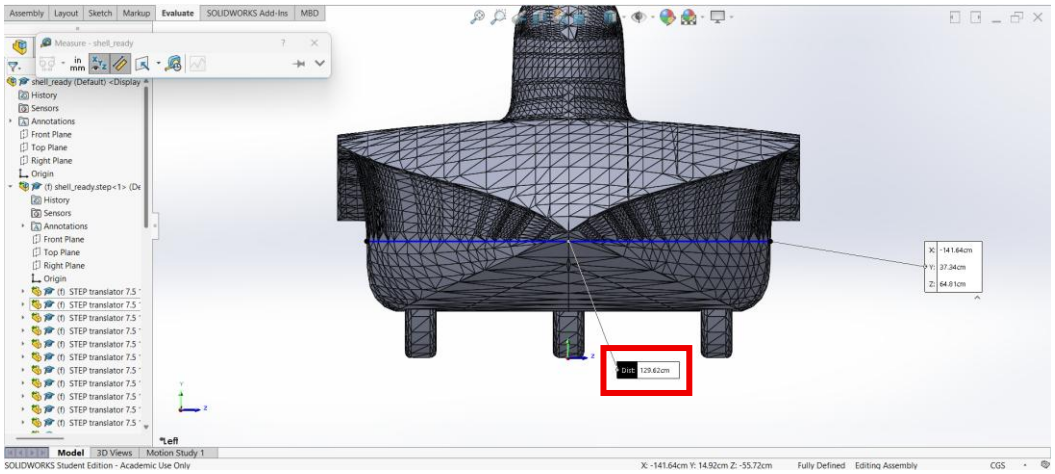
Total cost (with spare tire): ₹16000(approx. ₹20,000)

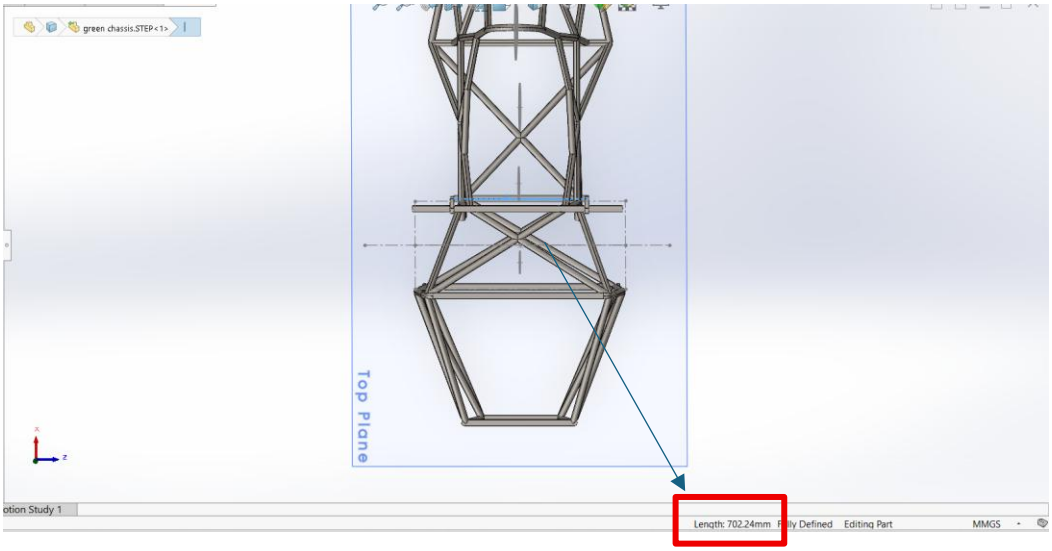
Having net weight of around **7-7.5Kg** (single tire and rim combination)

Md Asif (PnD)

Space available for Suspensions







Hence, the net space available for suspension is (approx.) =1100mm-700mm= 400mm

For each side its around 200mm (20 cm) = 80mm(tire)+ 120mm (left for knuckle and suspension arms) highly constrained

Md Asif (PnD)

Dynamics

Vehicle Configuration and Assumptions:

The vehicle is modeled as a tadpole three-wheeler with the following assumed parameters:

- Vehicle mass = 300 kg
- Center of gravity height = 400 mm
- Wheelbase = 2700 mm
- Track width = 1100 mm
- Ground clearance = 90 mm
- Static weight distribution (front/rear) = 50:50
- Rear wheel drive through hub motor

Tire and road parameters used in the analysis are:

- Tire size = 80/100-17
- Tire radius = 296 mm
- Tire width = 80 mm
- Coefficient of friction, μ= 0.82
- Rolling resistance coefficient, C_{rr}= 0.009

Environmental and aerodynamic assumptions are:

- Air density, ρ= 1.2 kg/m³
- Drag coefficient, C_d= 0.32
- Frontal area, A= 0.9 m²

These values are suitable for a first-pass design study and will be refined once detailed vehicle geometry and body design are finalized.

Since exact component packaging is not finalized, the vehicle center of gravity is assumed at 400 mm above ground for preliminary stability, braking, and suspension calculations.

1. Static Load Distribution

The total vehicle weight is calculated as:

$$W = mg = 300 \times 9.81 = 2943 \text{ N}$$

Assuming a 50:50 front-to-rear static weight distribution:

- Front axle load = 1471.5 N
- Rear axle load = 1471.5 N

Since the front axle has two wheels, the static load on each front wheel is:

$$W(front\ wheel) = \frac{1471.5}{2} = 735.75 \text{ N}$$

Thus, the static vertical loads are:

- Each front wheel = 735.75 N
- Rear wheel = 1471.5 N

These values are particularly important for front suspension design because they form the **basis for estimating spring loads, upright loads, and braking/cornering load transfer**.

2. Road Load Analysis at 80 km/h

The vehicle speed considered in this analysis is:

$$v = \frac{80}{3.6} = 22.22 \text{ m/s}$$

Rolling Resistance

Rolling resistance is calculated using:

$$F_{rr} = C_{rr} mg$$
$$F_{rr} = 0.009 \times 300 \times 9.81 = 26.5 \text{ N}$$

Aerodynamic Drag

Aerodynamic drag is estimated using:

$$F_d = \frac{1}{2} \rho C_d A v^2$$

Substituting the assumed values**:**

$$F_d = \frac{1}{2}(1.2)(0.32)(0.9)(22.22)^2 = 85.3 \text{ N}$$

Total Resisting Force

The total road load is the sum of rolling resistance and aerodynamic drag:

$$F_{total} = F_{rr} + F_d = 26.5 + 85.3 = 111.8 \text{ N}$$

Therefore, at 80 km/h the vehicle experiences a total resisting force of approximately 111.8 N.

3. Power Requirement

The wheel power required to maintain 80 km/h is:

$$P = F_{total} \cdot v$$
$$P = 111.8 \times 22.22 = 2484 \text{ W}$$
$$P \approx 2.48 \text{ kW}$$

Assuming a drive efficiency of about 85–90% for the rear hub motor system, the motor power required is approximately 2.8 to 2.9 kW.

4. Braking and Longitudinal Load Transfer

The theoretical maximum braking deceleration based on tire-road friction is:

$$a_{max} = \mu g = 0.82 \times 9.81 = 8.04 \text{ m/s}^2$$

This corresponds to roughly 0.82 g, which is the theoretical upper limit. In practice, a more realistic design braking range is about 0.4 g to 0.7 g.

For a representative braking condition of 0.5 g, the longitudinal load transfer is:

$$\Delta W = \frac{mah}{L}$$
$$\Delta W = \frac{300 \times 4.905 \times 0.4}{2.7} \approx 218 \text{ N}$$

Thus, during 0.5 g braking:

- **Front axle load becomes approximately 1689 N**
- **Rear axle load becomes approximately 1254 N**

5. Stability Considerations

The rollover threshold based on track width and CG height can be estimated by:

$$a_{roll} = g\frac{t}{2h}$$

$$a_{roll} = 9.81 \times \frac{1.1}{0.8} \approx 13.49 \text{ m/s}^2$$

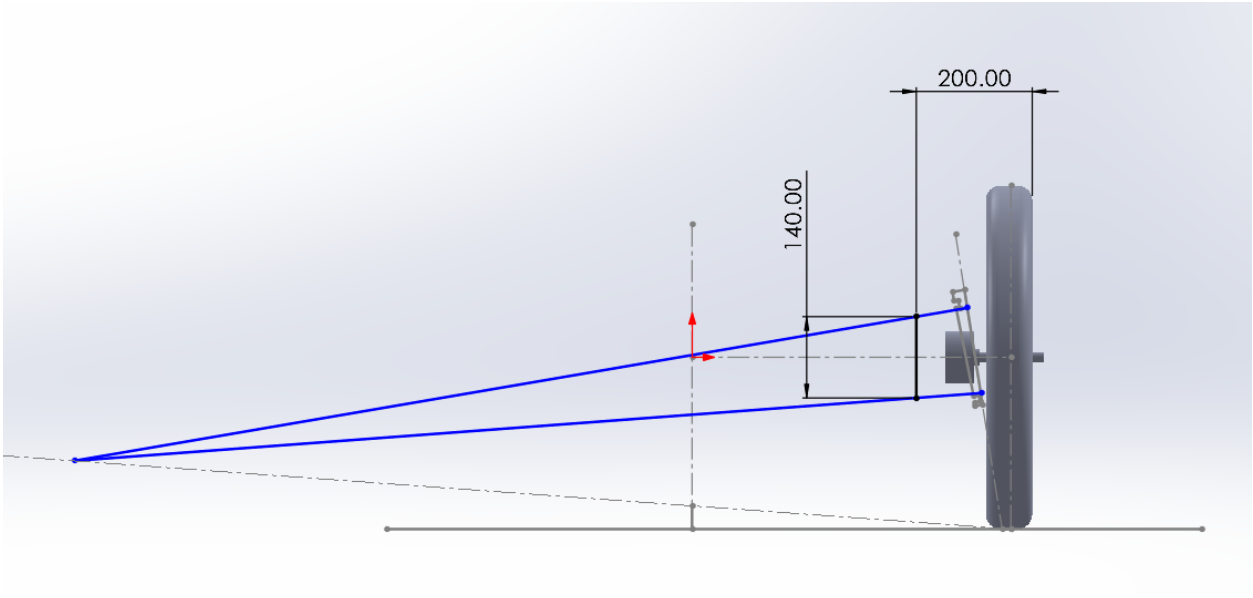
$$a_{roll} \approx 1.37g$$

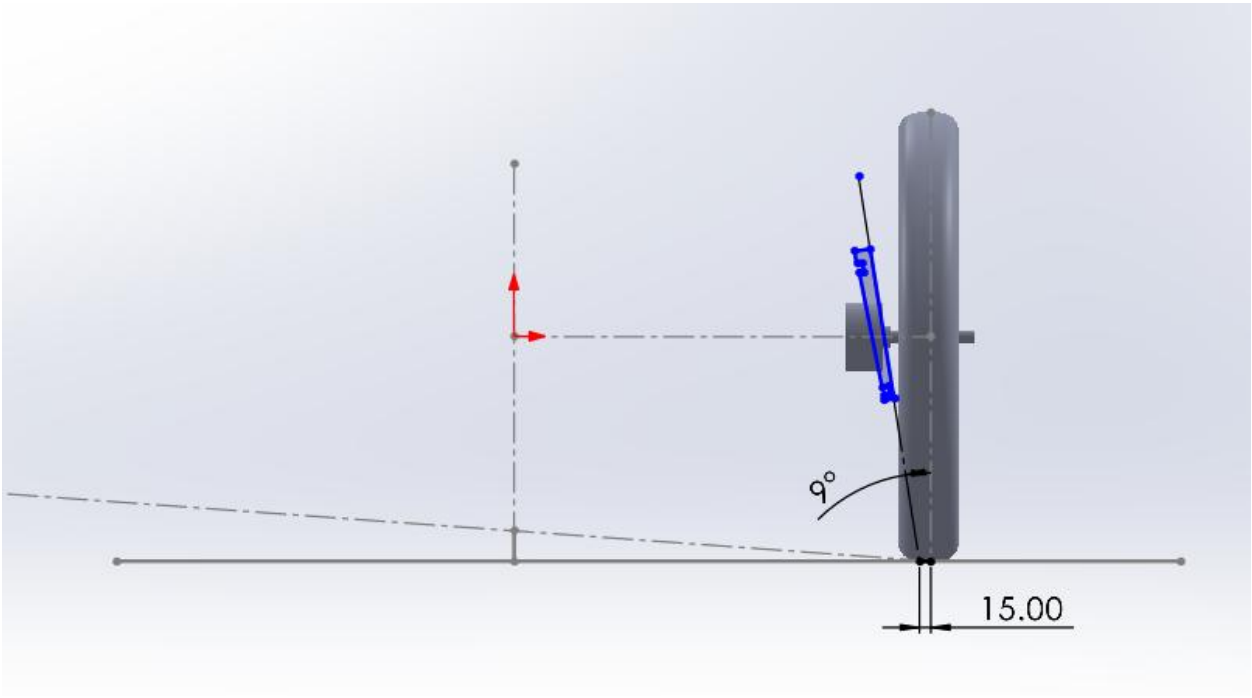
Since the tire grip limit is only about 0.82 g, the vehicle is expected to lose grip and slide before rollover occurs. This is a favorable stability characteristic for the current design assumptions.

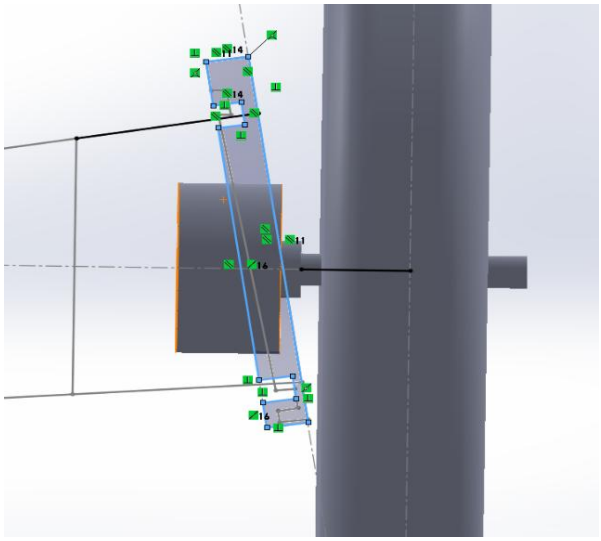
6. Conclusion

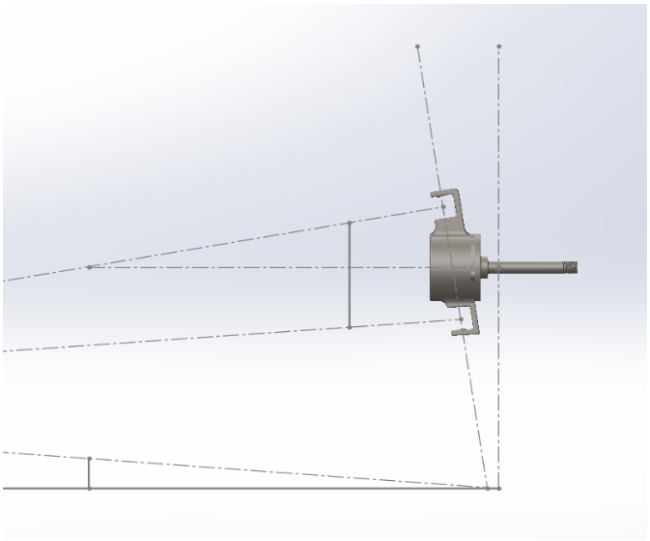
The preliminary vehicle dynamics analysis shows that the proposed three-wheeled tadpole vehicle is a lightweight and efficient configuration suitable for low-power operation. At 80 km/h, the total resisting force is approximately 111.8 N, and the power required at the wheels is about 2.48 kW. The vehicle exhibits acceptable stability characteristics under the current assumptions, with the tire grip limit occurring before rollover.

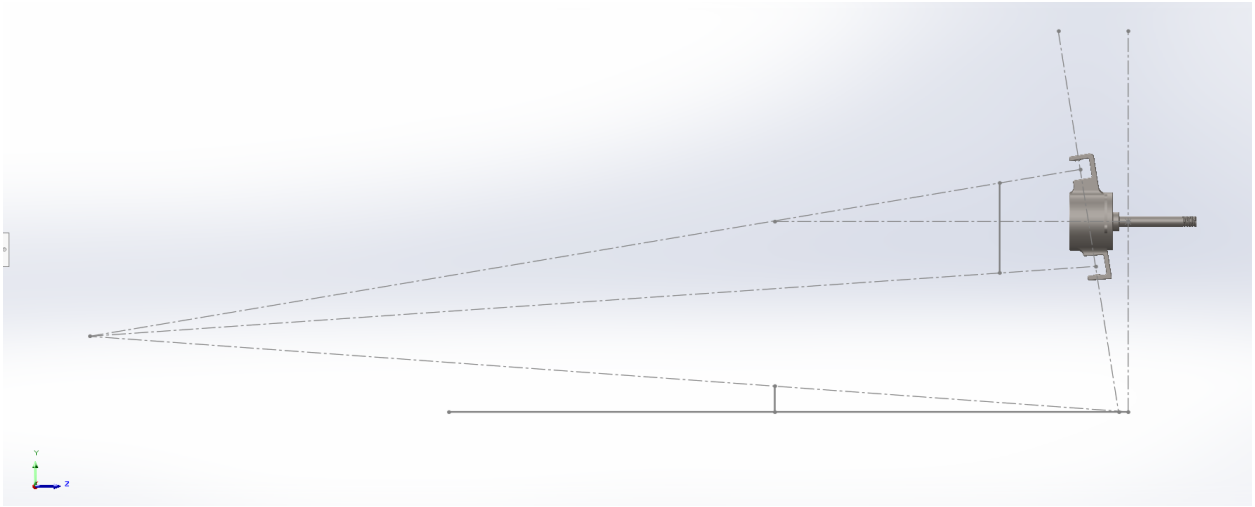
KPI & Scrub radius





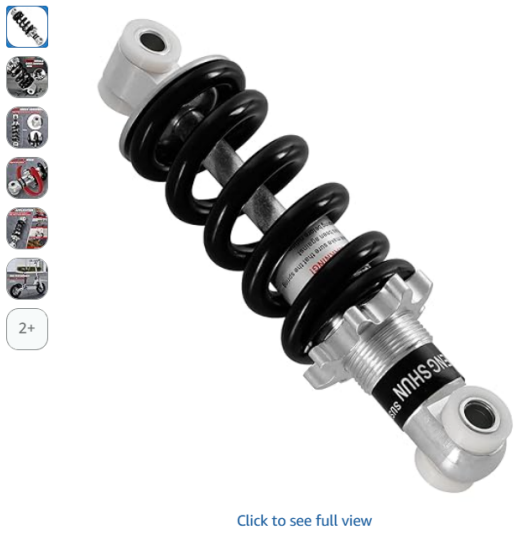






Coil over

1.



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150mm 1200LBS Mountain Bike Rear Shock Absorber: MTB Rear Shock with Adjustable Coil Spring, Widely Fits for Bicycle/E-Bike/Electric Scooter/Folding Bike/Go-kart/Etc

Brand: Tongze

3.8 ★★★★☆ (40)

₹6,860

Inclusive of all taxes

EMI starts at ₹241. No Cost EMI available EMI options

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Cashback	No Cost EMI	Bank Offer	Partner Offers
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Sale

Maxbell Maxbell 150MM 1200LBs Rear Shock Absorber Shocker Suspension For 2 Stroke ATV Buggy

8 sold in last 17 hours

Availability: In stock

~~Rs. 4,440.00~~ **Rs. 2,220.00**

Quantity: 1

Subtotal: **Rs. 2,220.00**

ADD TO CART

I agree with the terms and conditions

BUY IT NOW

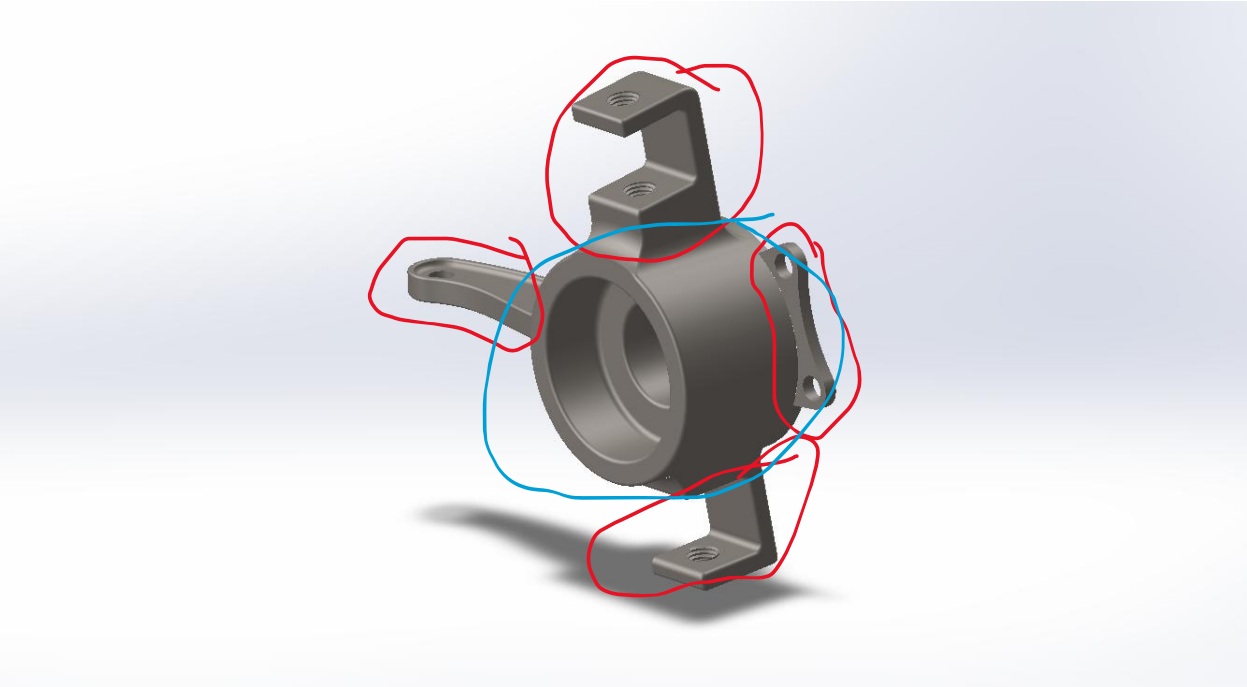
Md Asif (PnD)

Shops to check offline (**150mm coil over are very common and can be easily available in Delhi**):

- Chandan Shock Absorber (Tis Hazari nearby) Chandan Shock Absorber
- New Bharat Shocker
- Diamond International Pvt Ltd
- S K Shocker & Puncture

The front suspension coil over was selected based on vehicle mass, suspension geometry, and ride requirements. The total vehicle mass is 300 kg with a 50:50 weight distribution, giving a front wheel load of 75 kg per side. The motion ratio was calculated from the lower control arm geometry and corrected for the shock inclination angle of 30°, giving an effective motion ratio of 0.715. A target ride frequency of 2.1 Hz was chosen for a balanced combination of handling and comfort. Using this value, the required wheel rate was found to be 13.1 N/mm. After converting through the motion ratio, the required spring stiffness was obtained as 25.6 N/mm. For practical implementation, a 28 N/mm spring was selected as the nearest standard value. A 150 mm hydraulic coil over with preload adjustment and heavy-duty damping was therefore considered suitable for the front suspension system.

Knuckle



A 90mm wheel hub can be machined on a lathe machine
And the other mounting and arms can be CNC machined

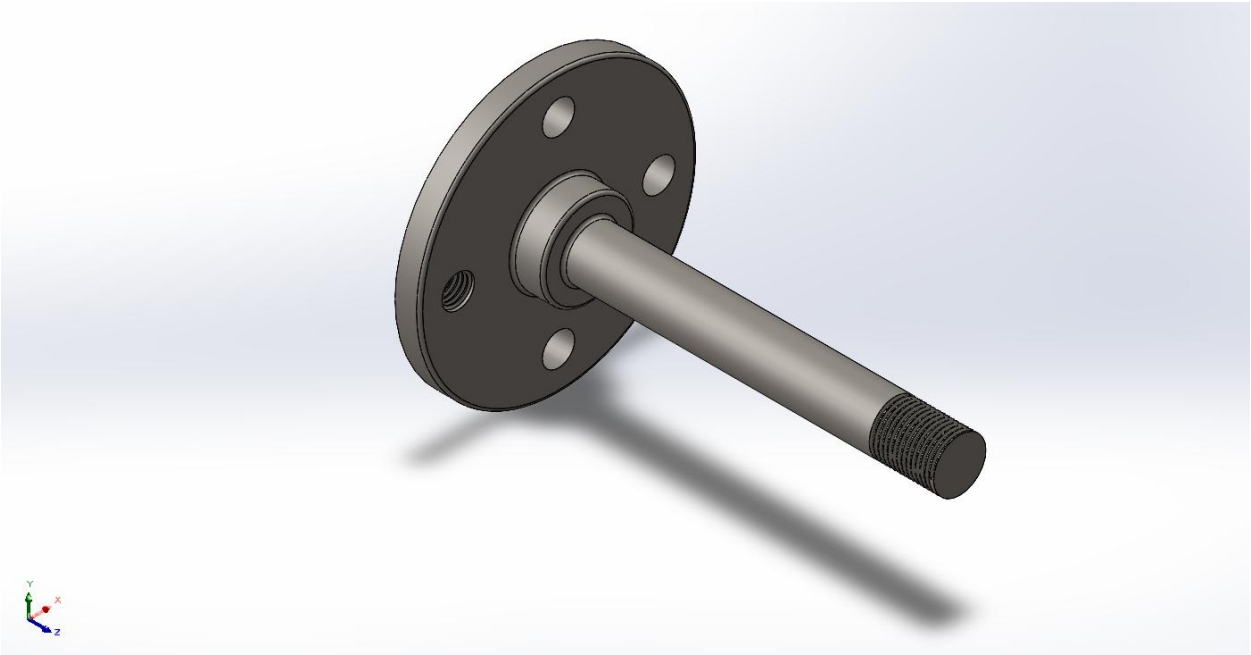
Cost for knuckle

Case	What shop says / gives	Engineering meaning	Your action	Reason
✅ Case 1	"Cut karke de denge" (70–80 mm piece)	Ideal raw stock	**BUY**	Perfect size + minimal waste
❌ Case 2	"Full rod lena padega"	3–6 m rod (~300 kg)	**REJECT**	Too costly, unnecessary
⚠️ Case 3	"4130 nahi hai, EN19 le lo"	Equivalent alloy steel (4140)	**BUY**	Same category, widely used
✅ Case 4	95–100 mm diameter available	Oversize stock	**BUY**	Machining allowance needed

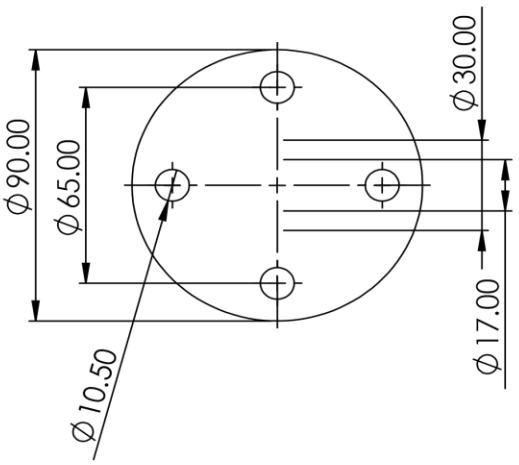
If they sell in kg (for our 2.49kg overall knuckle weight) cost nearly around = 600-900 (200-300 rupee/kg) for 3 kg
Labor cost around 1500-3000 rupee

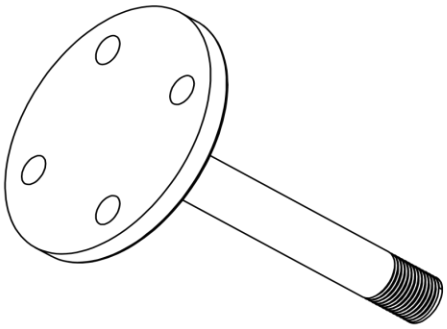
Md Asif (PnD)

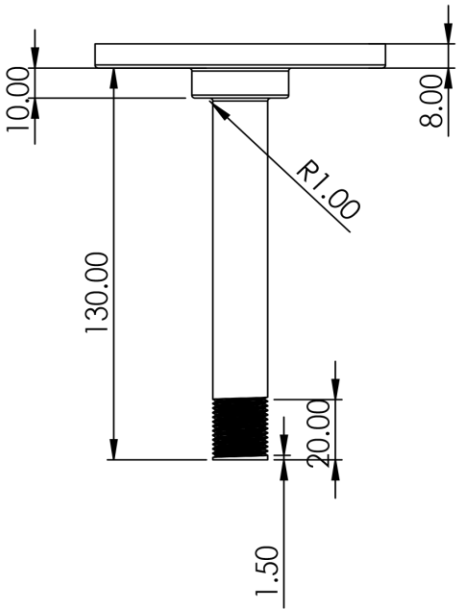
Spindle

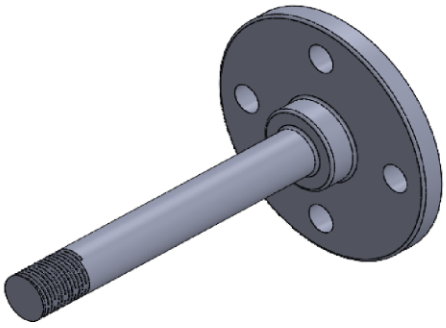


Total 90mm chromoly rod needed is around 200mm
For both the spindle and the hub
So, weight of the rod is around 10kgs
Cost of the 90mm rod required for the spindle and hub is around 2000-3000 rupee









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APPV'D								
MFG								
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				WEIGHT:			SCALE:1:2	SHEET 1 OF 1

Md Asif (PnD)

Heim joint

Control arm

Cost estimation

	A	B	C	D	E
1	**Component**	**Specification / Assumption**	**Quantity**	**Unit Cost (₹)**	**Total Cost (₹)**
2	Tire	Michelin City Extra 80/100-17	3 (2 + 1 spare)	1600 – 1900	4800 – 5700
3	Rim	17×1.85 Aluminum Alloy	2	4500 – 6000	9000 – 12000
4	Spindle (Chromoly)	CNC + Lathe	2	1500 – 2500	3000 – 5000
5	Knuckle + Hub	CNC + Lathe	2	1000 – 2000	2000 – 4000
6	Ball Bearings	6203 type	4	150 – 300	600 – 1200
7	Heim Joints	M8–M12 mix	4–6	300 – 700	1500 – 3000
8	Control Arms	4130 chromoly rod	4	1000 – 1750	4000 – 7000
9	Bolts	M8 + M12 (high grade)	Set	500 – 1000	500 – 1000
10	Coilover	150 mm adjustable	2	3000 – 7000	6000 – 14000
11	Brake Rotor	Apache RTR type disc	2	800 – 1500	1600 – 3000
12	Brake Caliper	Apache RTR single piston	2	1200 – 2500	2400 – 5000
13				Total Range	36000-50000