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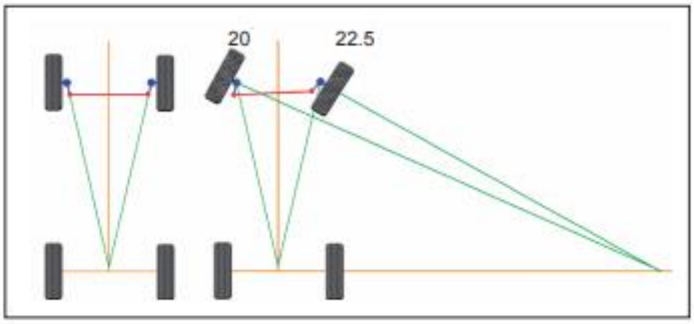
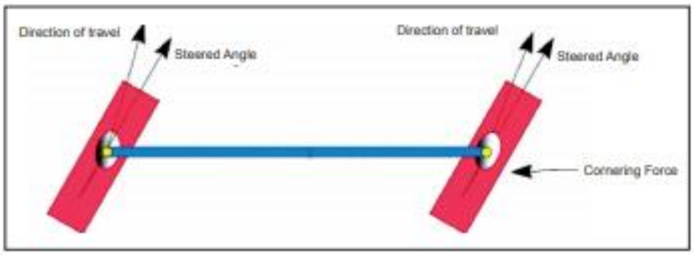
Ackermann Condition of Turning

1.introduction :

When a vehicle travels round a bend, the inside wheel must follow a tighter curve than the outside wheel. To achieve this, the geometry of the steering must be arranged to turn the inside wheel through a larger angle than the outside wheel. The ‘Ackerman’ steering geometry provides a simple solution to this problem. Shown is a representation of true Ackerman.

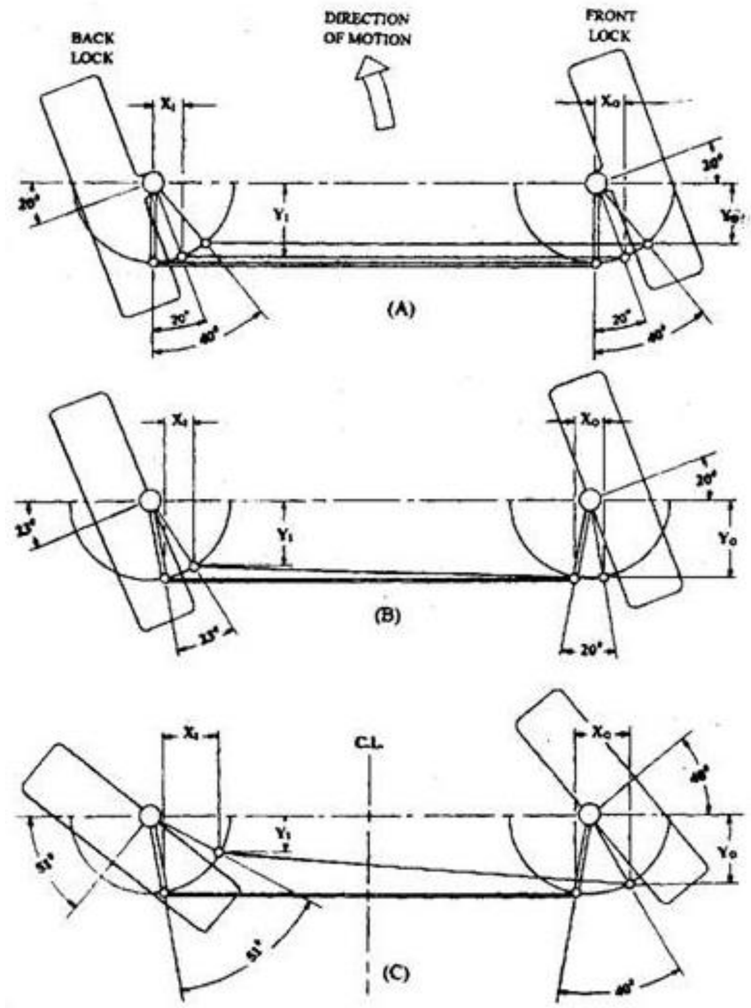




This geometry results in the inside wheel turning through a smaller radius than the outside wheel. This allows the vehicle to travel around a curve without scrubbing the tyres. In practice the steering linkage doesn’t need to produce true Ackerman. It is achieved by a combination of the steered angle and the slip angle produced by the cornering force.The slip angle on the outside wheel is greater than that of the inner and this produces varying degrees of dynamic Ackerman effect.

The self propelled motor vehicle almost from the beginning, used the double pivot wheel steering system. This was invented for horse drawn vehicles in 1817 by George Lankensperger, a Munich carriage builder. In England, Rudolph Ackermann acted as Lankensperger’s agent and a patent of the double-pivot steering arrangement was taken in his name.
With this layout of the linkage the track rod arms are set parallel to each other and a track rod joins them together. In the straight ahead position of the steering, the linkage and axle beam forms a rectangle, but, as the stub-axles are rotated about their king pins, the steering arrangement forms a parallelogram. This linkage configuration turns both wheels the same amount. the parallel-set linkage positioned to provide both a 20 degrees and a 40 degrees turn for the inner and outer wheels.
Charles Jeantand in 1878 introduced an improvement to the Ackermann linkage layout in

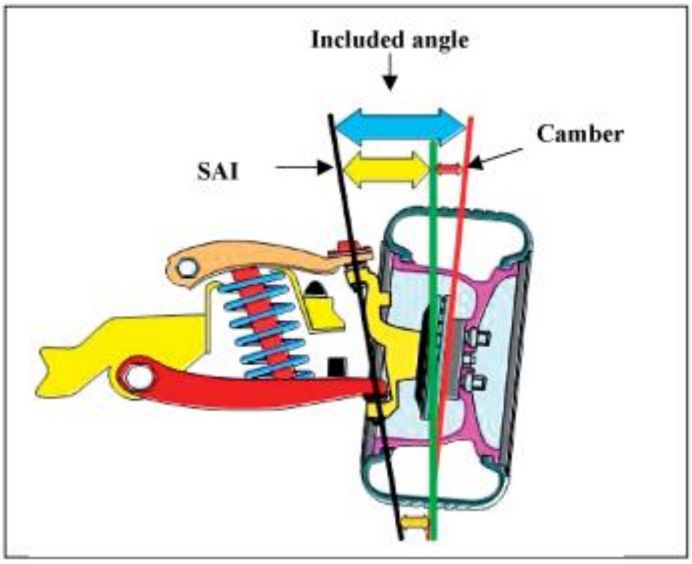
which inclined track rod arms form trapezium. This trapezium linkage configuration allows the inner wheel to rotate about its king-pin pivot by a greater amount than the outer wheel, which is necessary for providing semi-true-rolling. True rolling is obtained in the straight ahead position and on the left and right hand turns (locks). In between these three positions, only partial true rolling occurs. The degree of departure from true rolling and hence the amount of tyre scrub occurrence depends mainly on the ratio of track-rod to track-rod-arm lengths, and on the track-rod-arm angular inclination or set. In case the steering linkage dimensions and settings are carefully selected, a very little misalignment takes place for angle of turn up to about 15 degrees, beyond which the error increases rapidly. Also the deviation of the linkage from the theoretical true-rolling angles can readily be corrected by the tyre's side-wall flexibility and tread distortion, provided the angular error between the steered wheels is small. Since the rear wheels turn on a smaller radius than the front wheels, it is easier to manoeuvre a vehicle in reverse than in the forward direction when parking.



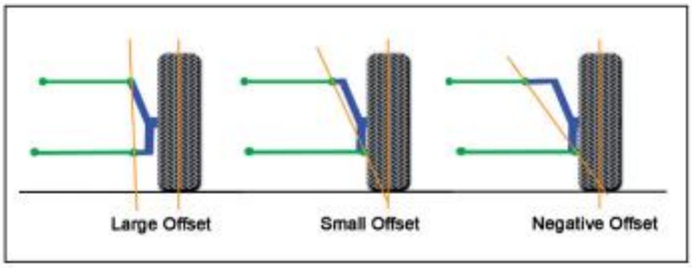
2.Steering Geometry

2.1.Steering Axis Inclination

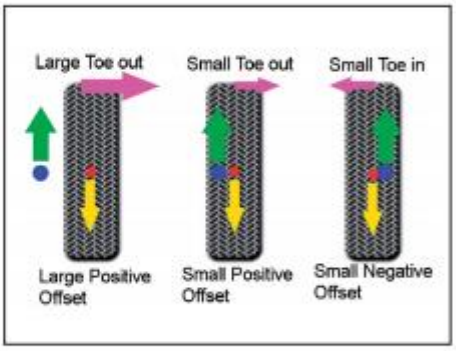
The steering axis inclination is the angle formed by a line drawn through the upper and lower swivel joint or steering axis. The inclination of the steering axis is necessary to allow the steering axis line and the contact point of the tyre to intersect close to the road surface.



The advantage of this arrangement is to reduce the offset between the steering axis line and the contact point of the tyre. The size of the offset, also known as the scrub radius, affects the effort required to turn the steering. A larger offset increases the steering effort. Reducing the offset will reduce the loading on the stub axle.



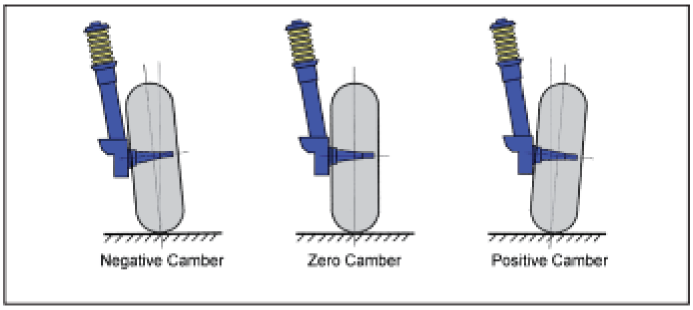
External forces applied to the wheel will attempt to change the direction of the wheel. When the offset is large, the lever ratio is large and the tendency for the wheel direction to change will increase. A reduced offset will limit the effect of bumps, braking forces and acceleration forces on the steering, making it easier for the driver to control the direction of the vehicle. A small toe-in effect under braking can increase stability. This is usually achieved by creating a small negative offset. In general, a front wheel drive vehicle with a positive offset will be set with a small amount of toe-out and rear

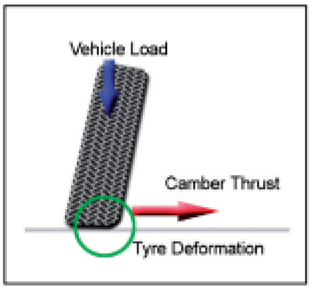


wheel drive with a small amount of toe-in. When a negative offset is used then the opposite will apply. Shown in the diagram bottom left is the effect of the braking forces on different offsets. The green arrow is the driving force, the yellow arrow shows the braking force and the purple arrow will show the resulting effect on the toe angle. Steering axis inclination also contributes to the directional stability of the vehicle. This effect is because the inclined steering axis causes the body to lift when the steering is turned. The weight acting on the steering axis will always force the wheel to the straight-ahead position to the steering.

2.2.Camber Angle

The camber angle is the inward or outward lean of the wheel relative to the vertical reference. Originally, the camber angle was used in a similar way to the steering axis inclination. Shown are the three possible options for camber. As you can see the positive camber

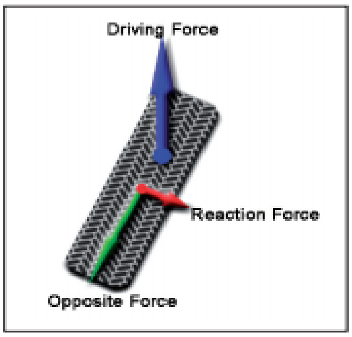


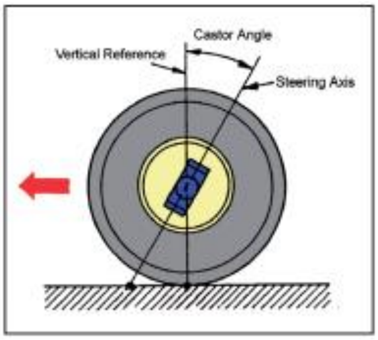


reduces the offset when combined with the SAI. The downside to positive camber is the tyre thrust generated at the contact with the road. In order for the tyre to sit on the road surface some deformation of the tyre must occur. A reaction thrust is generated by the tyre tending to force the tyre to move outwards. For example, when a vehicle is travelling around a left hand bend the positive camber will tend to force the tyre to the right and reduce the cornering ability of the vehicle. If you also consider that the body roll experienced during cornering will increase the positive camber on the outside wheel this effect is not very desirable. To reduce this effect, high performance vehicles will use a negative camber arrangement. Again, this will generate a camber thrust but this time in the same direction as the corner. Both negative and positive camber will increase the tyre wear due to the deformation that occurs with this set-up. As a result, most modern vehicles will tend to be set close to zero camber. This reduces wear and rolling resistance generated by the tyre deformation.

2.3.Castor Angle

The castor angle is the rearward lean of the steering axis relative to the vertical reference. The main purpose of the castor angle is to create a self-centring effect in the steering. Tilting the steering axis in this way means that the driving force acts at the point where the castor angle intersects the road. The resistance between the tyre and the road creates an opposite force that acts along the axis of the tyre. The effect is to generate side force, pushing the tyre back in line with the driving force. The further away from the straight ahead position the greater the side force. The difference between the vertical reference and the point at which the castor angle intersects the road is called the castor trail. The larger the castor trail the greater the self centring effect. Increasing the castor angle will increase the weight of the steering. Generally, larger castor angles are used on higher performance vehicles to maximize stability at speed. The trade-off for increasing the castor angle is increased steering effort and tyre wear.

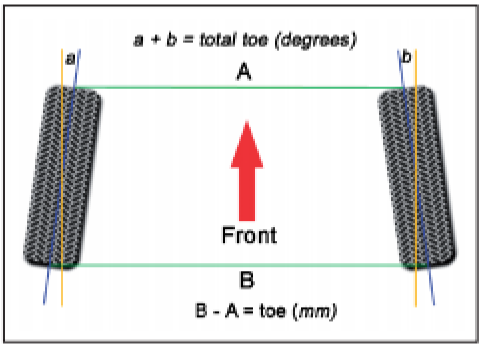




2.4.Toe Angle

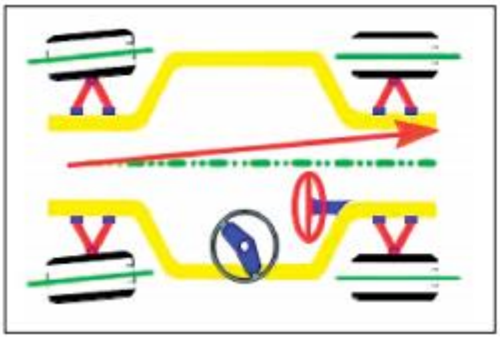
The toe describes the angle of each wheel relative to the centre line of the vehicle when viewed from above. The ideal toe angle should ensure that the front and rear wheels are parallel as the vehicle is driving along the road. To achieve this, the static toe angle will have to be set to accommodate the movement in suspension linkages and steering joints. The toe angle can be described as an angle or in terms of the difference measured between the front and the rear of the wheels on an axle. Measuring the toe would appear to be quite simple and if you measure the toe angle it is. However, if the toe valve is specified in mm, the method of measurement must also be specified. There are three methods used for measuring the toe in mm. If you use a different method of measurement to adjust the toe to that used by the manufacturer then the toe on the vehicle will be incorrect, leading to increased tyre wear.

The three methods shown are European, American and Japanese. You can see from the diagram that the measured toe in mm is very different for each method but the angle is always the same. Correct toe adjustment is necessary to ensure that the vehicle drives in a straight line. Incorrect toe can lead to pulling problems and increased tyre wear



2.5.Thrust Angle

Most vehicles nowadays have independent rear suspension. This allows the manufacturer to arrange the rear wheels with an amount of toe and camber. These angles affect the alignment and handling of the vehicle in the same way as the front wheels. If the rear toe is misaligned, then they will try to steer the vehicle. The relationship between the rear toe and the centre of body is called the thrust axis. Any thrust from the rear is compensated for by the front wheels turning to try to achieve the lowest rolling resistance.The steering wheel will now be out of alignment and the vehicle will crab. As you can see, there are many variables to consider and, depending on the design of the steering and suspension, varying degrees of compromise have to take place. This is accommodated by the compliance of the flexible bushes used in the steering and suspension mechanism and of course the tyre itself. Only when the basic principles of steering geometry are understood can a technician undertake diagnosis and rectification. The next article will look at how these angles are measured and adjusted.



3. advantages, .Disadvantages:

3.1. advantages:

1.Compared to conventional gearboxes have smaller dimensions.
2.Easier to sort through the constant rounds of shot.
3.Greater durability than conventional bikes in gear.
4.Easy to achieve high transmission ratio due to the size.
5.They have higher gear ratios.

3.2.Disadvantages

1.More expensive than conventional production of gearboxes.
2.More complex than conventional transmission Gear.

4.Reference:

1. (Dallin Colgrove) 2019-03-15 Steering System for SAE Baja .
2. RcTek - Radio Controlled Model Car Handling - The Ackerman Steering Principle.
3. racing-car-technology. Steering Ackerman4.doc.
4. mentlibrary/Sep 09/TT _ Sept 09, Steering Geometry.
5.the Ackermann Principle as Applied to Steering (Automobile).