

## Understanding Bump Steer

A wheel alignment is done following collision repairs and all of the suspension angles are within specifications, yet there is a handling problem during the test drive. The problem, in many cases like this, is a condition known as bump steer. Bump steer occurs when individual toe changes on a vehicle unequally from side-to-side. Bump steer is caused by steering linkages positioned at incorrect or uneven angles when compared on the left and right sides of a vehicle.

Bump steer has many variables: steering system design, geometric relationship of the steering parts, alignment angles, and sometimes even vehicle maker's design compromises. All of these variables have the potential to cause bump steer to be severe, minor, or possibly not evident. The primary cause of toe changing under a load is nonparallel steering linkages that cause toe to change in unequal amounts from side-to-side. Nonparallel steering may occur for different reasons, one of them being collision damage.

One situation that causes bump steer is a rack and pinion steering gear not attached parallel to datum. This positions the tie rods at unequal angles from side-to-side. When this occurs and the vehicle travels through a jounce and rebound cycle, the tie rods travel in unequal arcs causing unequal side-to-

side lateral movement (see Figure 1). Unequal tie rod travel causes a push/pull effect that may be noticeable in the steering wheel. It may also cause the vehicle to have an awkward handling sensation, such as floating, as the vehicle travels through the jounce and rebound cycle.

If a rack and pinion gear is sub-frame (engine cradle) mounted, the same applies. The tie rods must set at equal angles for both the left and right side of the vehicle. Also, the tie rods must be positioned at near the same angle to both the left and right control arms. Following repairs to a collision damaged vehicle, it's critical that steering parts are returned to the original geometric position that the vehicle maker designed.

### SLA SUSPENSIONS

When evaluating short arm/long arm (SLA) suspensions, the design of the control arm may exaggerate bump steer on a vehicle that has incorrectly positioned steering linkages. Bump steer problems on this type of suspension are often corrected by the vehicle maker using specific toe settings that will compensate for bump steer. Typically, bump steer on an SLA suspension is mild or unnoticeable.

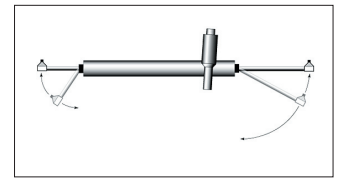


Figure 1—A steering rack that is not parallel will cause the tie rod ends to travel in different arc paths.

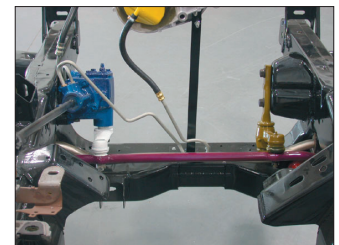


Figure 2—Proper placement of the steering gear box and pitman arm is critical to maintaining a center link parallel to datum.

The prominent cause for bump steer on SLA suspensions is almost always combined with parallelogram-style steering linkages such as the pitman arm and idler arm. The idler arm and steering gear, which contains the pitman arm, are mounted to the vehicle frame. These center link attachment points must be parallel to datum and in proper relationship to the lower control arm (see Figure 2). Parallelism is required, so during jounce and rebound, the tie rods travel in an identical arc path with the lower control arms. If parallelism is not maintained, there will be a floating sensation.

Depending on vehicle design, the vehicle maker may have designed slotted frame-mounting holes for the idler arm. An example of this is the earlier GM F-body with a parallelogram steering system. These vehicle frames have slotted mounting holes that allow the idler arm position to be changed. This allows for positioning the steering linkage level to datum. Most mounting points for idler arms can't be adjusted, so often times this attachment point is overlooked when the idler arm is replaced. The idler arm is bolted into place and the center link is not inspected for parallelism, therefore it is possible to create a toe change condition that was not present before collision damage occurred.

There are also vehicle design variations that affect basic bump steer. An example would be suspension design, primarily SLA, that has the tie

rod located rearward on the steering knuckle. By the nature of this design, these are often more susceptible to some toe change affected by load or ride height. This occurs because of the natural tendency for the wheels to push outward when moving forward. To correct this condition, some vehicle makers compensate by specifying a positive or negative toe setting for the vehicle.

## MODIFIED STRUT SUSPENSIONS

Modified strut suspension designs, that have a rack and pinion mounted to the sub-frame, are susceptible to bump steer as the vehicle ages and the springs sag. Spring sag can cause bump steer by unequal side-to-side vehicle settling. When this occurs, the steering linkage may become nonparallel in relation to the control arm arc and bump steer symptoms are likely to occur.

## INSPECTING FOR BUMP STEER

When inspecting a vehicle for bump steer, set the front wheels on turntables and zero the turntables. Pull down on the front of the vehicle 50–75 mm (2–3") and observe any toe change from side-to-side. Raise the vehicle 50–75 mm (2–3") and again observe the toe readings from side-to-side. Ideally, the toe readings should not vary or vary only a small amount. If significant change is

noted, further checks should be made to determine which parts on the vehicle are damaged or assembled incorrectly. The downside to this test is that there are no specifications for this process from the vehicle makers.

Volkswagen and Audi have a specific raised toe setting, called Toe Constant "S." These toe settings are used on the front wheels of the vehicle. A raised toe setting ensures the steering linkage is parallel. It also ensures that the toe angle is set to a vehicle that is at a specified height. Doing this ensures that any changing of toe under a load is maintained and controlled.

## CONCLUSION

Many vehicles depending on design, use, and alignment angles, may have bump steer. Though it is not possible to categorize these vehicle designs as susceptible or not susceptible to bump steer, vehicles that appear to have a handling concern should be inspected for nonparallel or unequal length side-to-side steering parts, which could all lead to bump steer.

More information on steering linkage parts, their location, and how they are installed can be found in the new I-CAR Steering And Suspension Program 3. Checking alignment angles, and inspecting for bump steer, can be found in the new I-CAR Steering And Suspension Program 4. Both courses will be available later this year. Watch for them in your area.