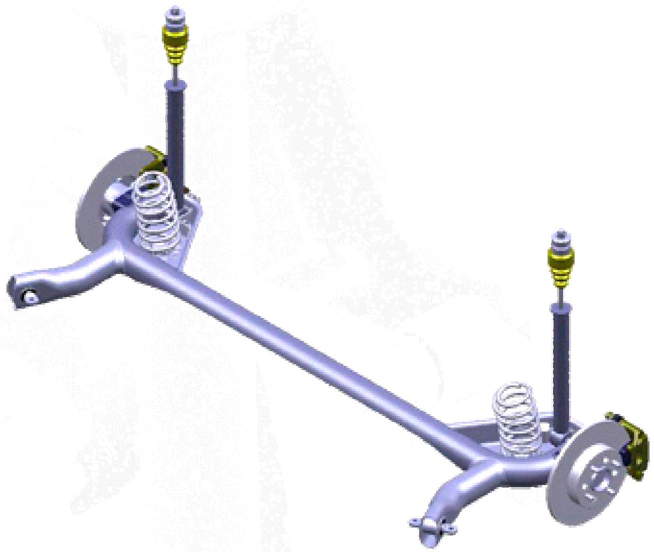
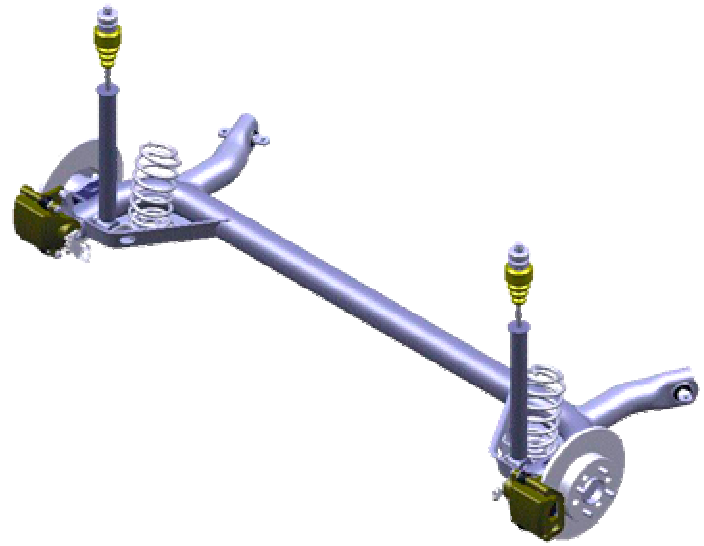
TWISTBEAM: SYSTEM PHILOSOPHY





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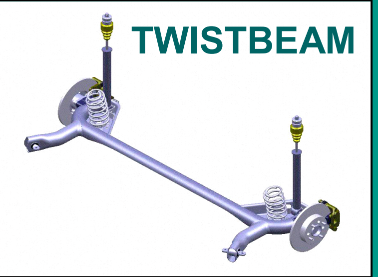

The TwistBeam suspension concept is a semi-independent type. The use of the concept in a volume production vehicle was pioneered by Volkswagen and has subsequently become increasingly popular on small front wheel drive cars.

The system comprises an assembly of two trailing arms that are interconnected by a transverse beam. The connections between the beam and the trailing arms are rigid. The longitudinal position of the beam is a design variable. However, generally the system takes the form of a 'H' shaped frame. There are no other links within the system. The forward mounting of the frame is pivoted with respect to the vehicle body using a compliant mounting and bracket arrangement. Coil springs are regarded as the most appropriate springing media for use with this suspension concept. The system is not regarded as being suitable for rear wheel drive vehicles.

Three basic configurations of the system can be considered. With the transverse beam attached to the trailing arms in line with the pivot axis the system behaviour is very much like a pure trailing arm system. The next arrangement has the transverse beam attached part way between the bushings and the wheel centre. This configuration is the most common encountered. The third configuration has the transverse beam mounted in line with the wheel centres. This design requires additional linkage arrangements to control the system lateral forces and deflections, e.g. Panhard rod.

The twist beam system combines some of the performance features of a pure trailing arm system with those of a semi trailing arm system. During two wheel bump events the system pivots about an axis through the body mountings like a hinge with a behaviour similar to that of a pure trailing arm system. To accommodate the requirements of single wheel inputs and vehicle roll, the system undergoes large elastic deformation within the structural parts of the assembly . The performance of the system during these events is analogous to a semi trailing arm system.

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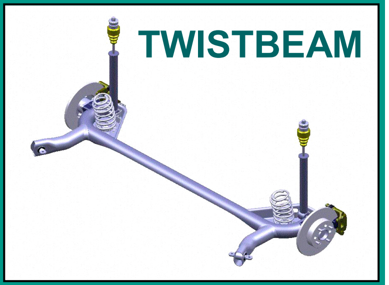

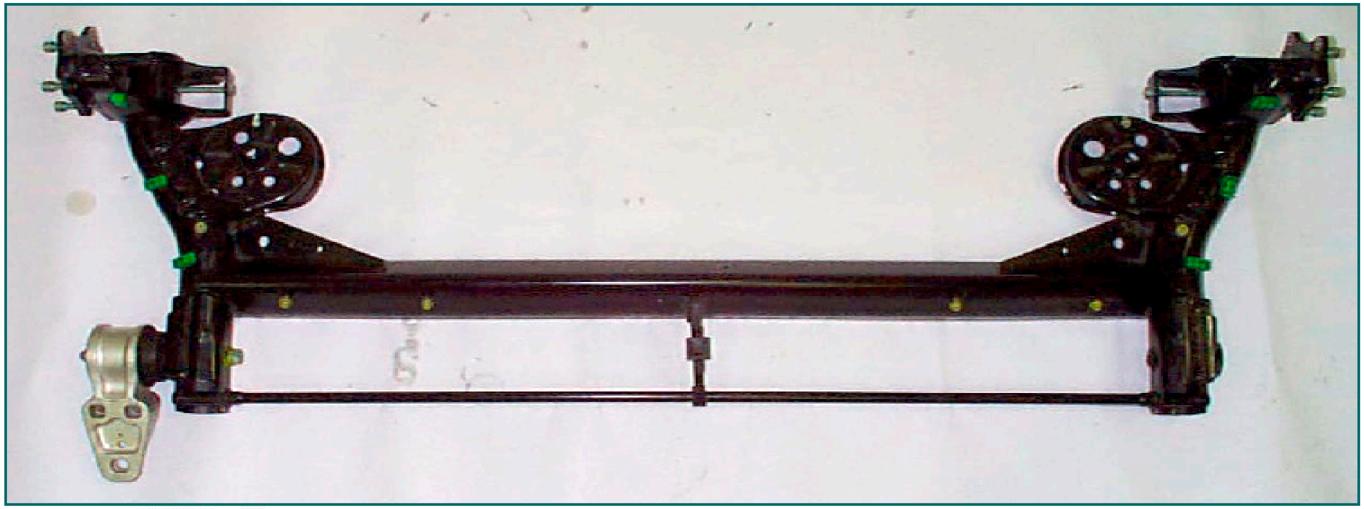

Typical example of a TwistBeam Rear Suspension System

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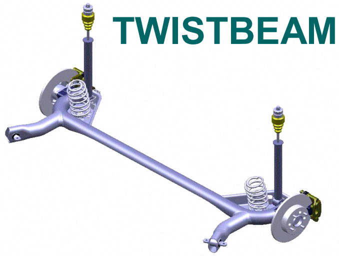

The longitudinal location of the transverse beam and the position of the flexural centre of the beam have an influence on the system characteristics. The instantaneous roll centre height is a function of the location of the beam flexural centre. The flexural centre lies on a plane section through the beam that experiences zero twist. It is the point on that section through which a transverse load can be applied without causing the section to twist. Rearwards movement of the beam raises the height of the roll centre. With the beam flexural centre above the bushings roll understeer is obtained. With the flexural centre below the bushings roll oversteer is obtained. The packaging requirements of vehicles often lead to installations where the flexural centre of the beam is below the bushings. This limits the potential to use the system structure to induce roll understeer characteristics.

The performance characteristics of a twist beam system can be summarised as follows:

For parallel two wheel inputs:

There is no camber change with wheel travel
There is no toe change with wheel travel. (Toe change may occur on some systems where a lateral link is used. In such cases the level of toe change is a function of the mounting locations of the link.)

For single wheel inputs and vehicle roll:

The roll centre height changes with system articulation. The roll centre height can be tuned by changing the longitudinal position of the transverse beam. Applying a lateral force at the tyre contact patch produces pivot deflections and trailing arm bending that induce toe out, e.g. an over steer characteristic. The positioning and design of the mounting bushes can be used to modify this characteristic. A very small camber change also takes place due to torsion and bending in the twistbeam structure.

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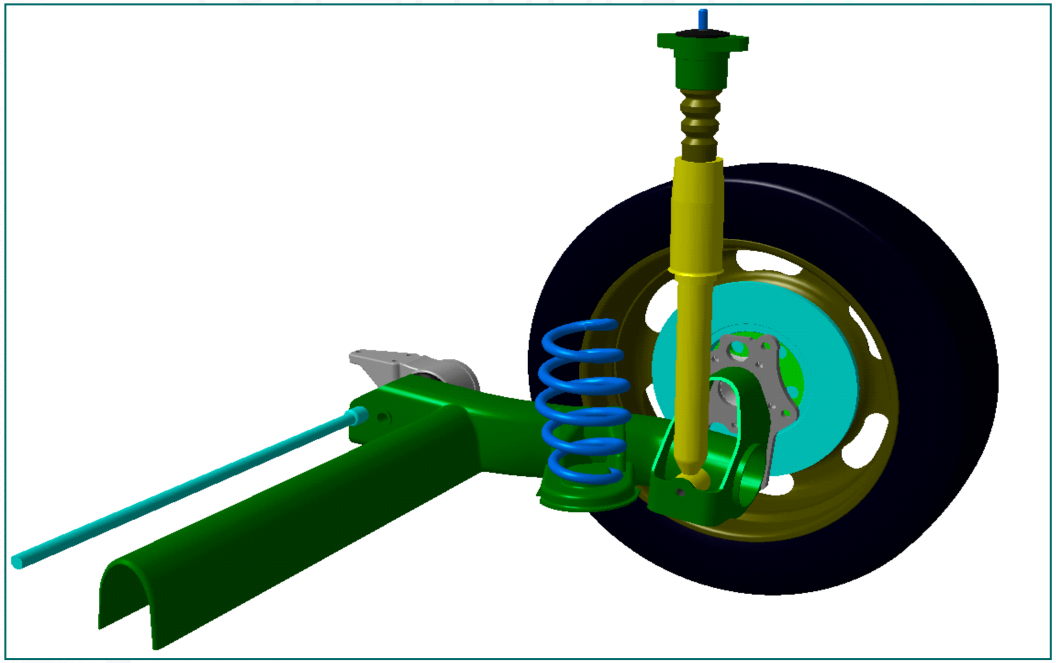

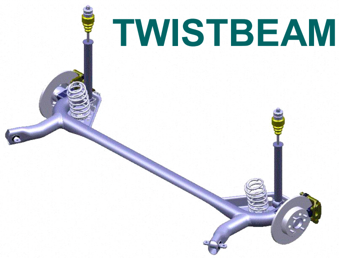

The twist beam concept has a minimal number of paths to transmit the wheel input loads through to the vehicle structure. Typically the pivot mounting bushes react all of the longitudinal and lateral loads and share the vertical loading with the suspension spring medium. The trailing arms connect the wheel hubs to the pivot mounting bushes and are linked together by the crossbeam. The loading experienced by the trailing arms and crossbeam is complex and is described later.

The location of the suspension spring with respect to the pivot axis has a significant effect on the design of the trailing arm. One target for the system designer is to obtain spring and damper displacements that are comparable with those of the wheel. Typically the spring ratios and damper ratios should be close to one. Such an arrangement avoids load magnification and allows the more refined control of the wheel motion when compared to a system with lower ratios. Spring and damper ratios close to one can be achieved by attaching the springs and dampers to the free ends of the trailing arm, close to the axle centre line. The vertical bending loading experienced by the trailing arm is minimised with this type of installation. However, the packaging of such an arrangement requires careful consideration and must be assessed with respect to the resulting different design requirements for the trailing arm.

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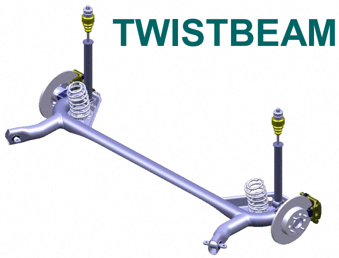
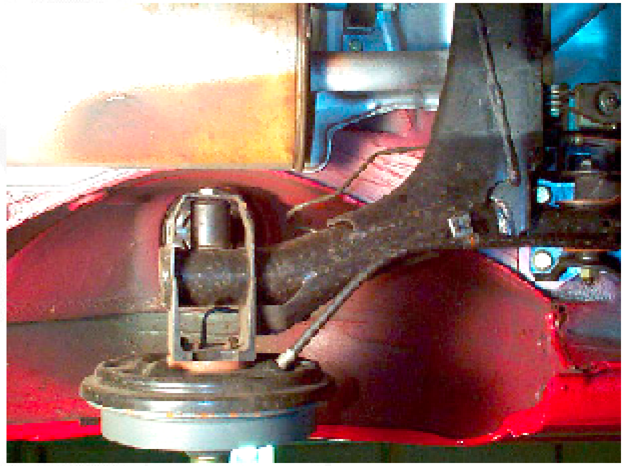
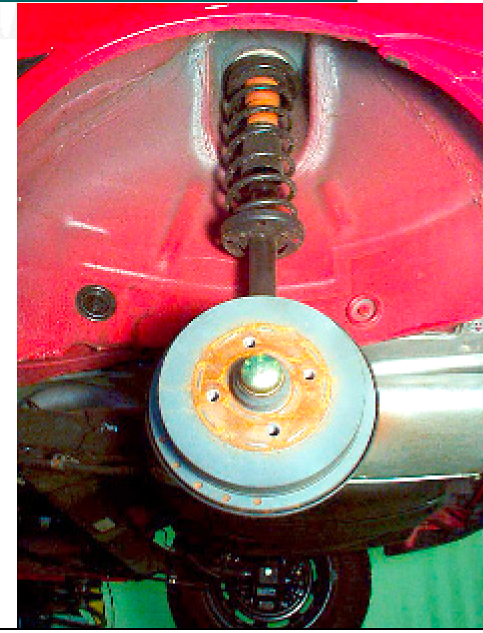




VW GOLF TWISTBEAM



There are generally two approaches to the design of an installation that permits the attachment of the springs and dampers to the ends of the trailing arms. The first to be considered requires that the spring media upper mountings be located high in the vehicle. The VW Golf provides an example of this arrangement. This allows the longitudinal torsional loading on the arm to be minimised but requires a robust body structure. The second approach provides a low position for the upper spring media mounting, but generally requires the spring media components to be mounted a distance inboard of the wheel. This is to avoid foul conditions between the tyre and the coil spring. Such an arrangement is undesirable as it increases the longitudinal torsion loading applied to the trailing arm and also results in considerable intrusion into the boot area.

The separation of the spring and damper components provides a compromise solution. This arrangement can reduce the requirements for structural mounting points high in the body and can also allow the spring to be mounted to a more robust part of the trailing arm. The arrangement requires that the designer compromises on the targets for the spring and the damper ratios. The maintenance of damper ratio has the higher priority. The Vauxhall Astra and Audi A6 utilise this type of arrangement.

The transverse beam is a key element of a twist beam system. It is subjected to a complex regime of loading.

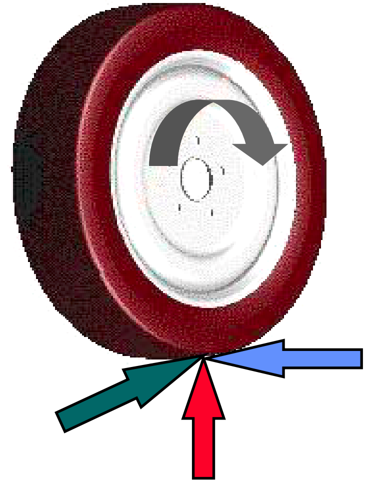
ULTRALIGHT STEEL AUTO SUSPENSION

TWISTBEAM: SYSTEM PHILOSOPHY

Basic Forces Acting on the Suspension

- 3 primary forces at tyre contact patch
  - **Longitudinal**
  - **Lateral**
  - **Vertical**

- Additional Torque Loading
  - **From Braking (Combined with a Longitudinal Force)**



To better understand the complex loadings in the twistbeam suspension system we must first look at the fundamental forces that are generated at the tyre contact patch. These forces act in the three primary directions as shown and there is an additional torque loading from brake reaction. There also torques generated about the other two axes due to offset loadings, trail, etc but these are of less significance. From these forces we can look at the movements in the suspension system and also examine how the forces are controlled by the suspension system.

Movements

- Longitudinal
- Lateral
- Ride
- Steer
- Camber
- Rolling

Forces

- Longitudinal
- Lateral
- Vertical
- Braking/ Acceleration

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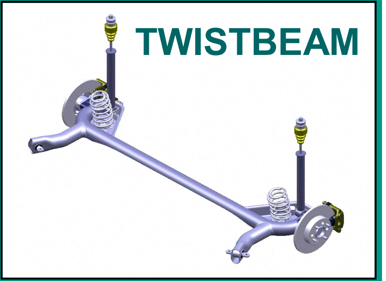

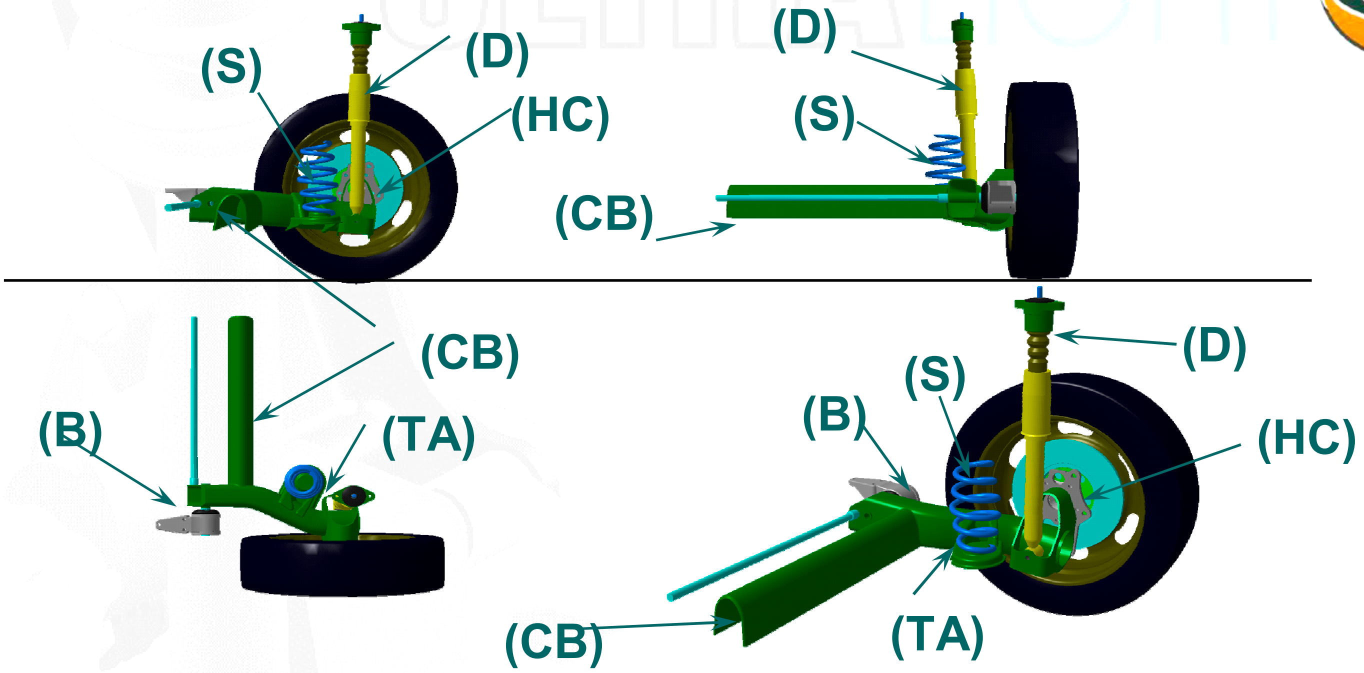

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ULTRALIGHT STEEL AUTO SUSPENSION

TWISTBEAM

MOVEMENTS

Longitudinal:- Deflection of bushes (B) allows fore and aft movement of the wheel.

Lateral:- No significant change in track is possible as track is controlled by the fixed width of the twist beam assembly and could only be achieved by bending of trailing arm (TA).

Ride:- Rotation about bushes (B) and twisting of the cross beam (CB).

Steer:- Steer can only be achieved by the whole frame moving by deflection of bushes (B) and by bending in trailing arm (TA).

Camber:- No significant change in camber is possible as it is fixed by the design of the twist beam assembly and could only be achieved by twisting of the trailing arm (TA) and bending of the cross beam (CB).

Rolling:- The wheel is able to rotate on bearings in the hub carrier (HC).

FORCES

Longitudinal:- Forces are resisted by tension and compression loads in trailing arm (TA) and . bending in the cross beam (CB).

Lateral:- Forces are resisted by bending and torsion in the trailing arm (TA) and . bending in the cross beam (CB).

Vertical:- Forces are resisted by loads in the spring (S) and damper (D) and by bending . and torsion in the trailing arm (TA) and also by torsion in the cross beam (CB) . during roll.

Braking:- Torque is taken by bending in trailing arm (TA).