Comparison of Mechanical to Air suspension

Introduction

In 1959 BPW Germany introduced the first Air suspension for their running gear and since then it has gone through a lot of innovation. Since the introduction of Air suspension, Mechanical suspension has not gone through a lot of innovative changes, it is however more robust. Due to its robustness, Mechanical suspension is used for heavy axle loads operating in extreme off-road conditions. BPW Air suspension can used for axle loads up to 14 tonnes and its application is suited for on- and off-road conditions carrying general and sensitive freight.

Technical advantages of Air suspension compared to Mechanical suspension

Compared to mechanical suspension, air suspension comes up with a whole host of benefits. When a trailer fitted with air suspension accelerates, the developing vertical vibrations are damped equally for loaded and unloaded conditions. A trailer fitted with mechanical suspension, the developing vibrations are damped more under loaded than unloaded conditions, see Figure 1. Hence air suspension protects loaded goods, vehicle, driver and the road with high ride quality in all loading states.

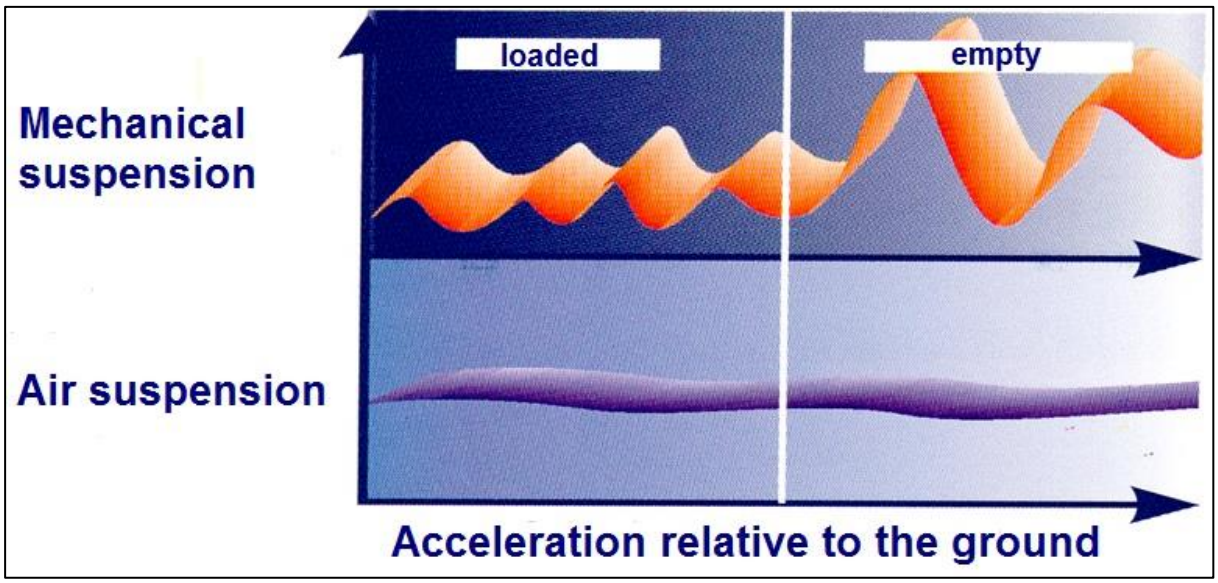

Figure 1: Damping characteristics of suspensions

Brake pressure is controlled via the load-dependent air bag pressure on air suspension. This control is significantly more precise than what is offered by mechanical suspension. Dynamic brake load equalisation is not possible with mechanical suspension. Under braking conditions the braking torque gets absorbed by the supports and rockers. This results in an axle load displacement from the front axle to the rear axle as shown by Figure 2.

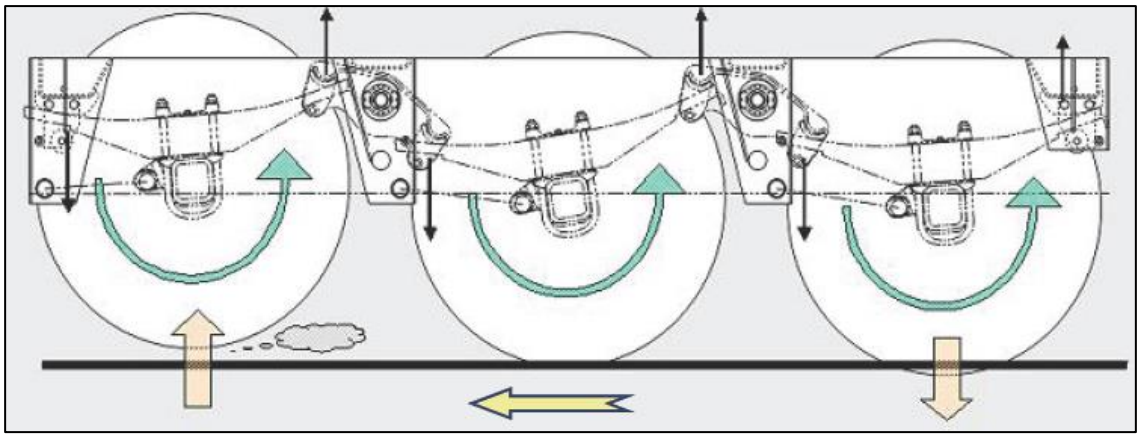

Figure 2: Braking torque on mechanical suspension

The axle load increases on the rear axle and decreases on the front axle. This then tends to “lock” the front axle under braking conditions. The lack of brake load equalisation can be compensated for by using different brake cylinders on the axles. With air suspension excessive braking is avoided and the tyres are handled with care, as air suspension units offer a dynamic brake load equalisation.

Another benefit of the air suspension is the vertical travel on the axle. The travel on a three axle aggregate (see Figure 3) fitted with mechanical suspension is limited to ±50mm on the 1st and 3rd axle and ±100mm on the center axle. The spring deflection under loaded conditions deflects an additional 22 to 46mm, dependent on configuration.

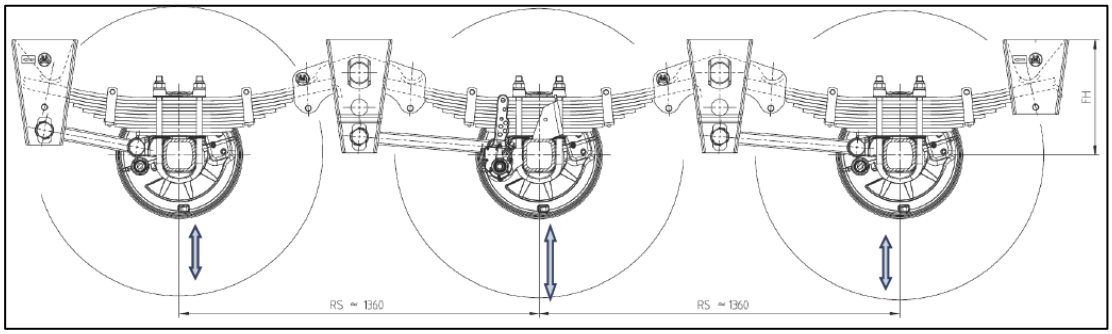

Figure 3: Axle travel on mechanical suspension

The axle travel on air suspension is from 190 to 220mm, depending on configuration. This allows for a better static load distribution. In addition air suspension has a greater travel safety and optimum use of the permissible vehicle height.

Air suspension is built up in such a way that they form a U-shaped connection. The U-shaped connection is formed from the axle, flexible trailing arms and hanger brackets as shown in Figure 4. This type of connection acts as a U-stabiliser.

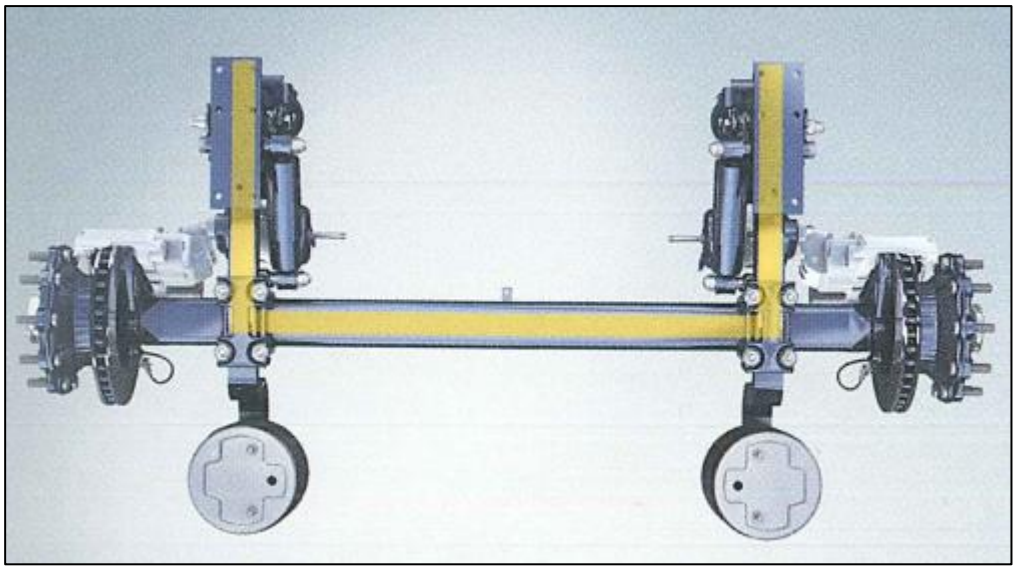

Figure 4: U-stabilisation of air suspension

For air suspension mechanical stabilisation is important, the reason is that when it comes to axle load equalisation, all airbags are directly connected to one air-line which ensures equal pressure on all airbags. When cornering, the roll stability is then taken up by the U-stabiliser.
In mechanical suspension a symmetrically mounted axle produces almost no auxiliary roll stiffness. In order to increase the roll stability, the mechanical suspension is additionally equipped with one or multiple U-stabilisers. The U-shaped round profile of such a stabiliser is pivot-mounted on its ends to axle beam and is supported centrally twice at the vehicle chassis.

Many additional functions made possible by electronics can be implemented only with air suspension. The axle lift function, which spares the tyres, is only available with air suspension. The wheelbase on multiple axle units can be chosen in a customised manner.

Lastly, air suspension units require less servicing, as they generate less drive by noise and are subjected to less wear without having to be lubricated regularly.

Conclusion

Air suspension offer far more advantages than mechanical suspension, however, the one big advantage of Mechanical suspension is their robustness and ease of maintenance which makes it great option for vehicles that operate in extreme conditions. From a safety perspective Air suspension far outweighs Mechanical suspension and these days is the preferred choice for suspension systems.