COMPLEXITIES OF MODERN SUSPENSIONS

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Complexities of Modern Suspensions

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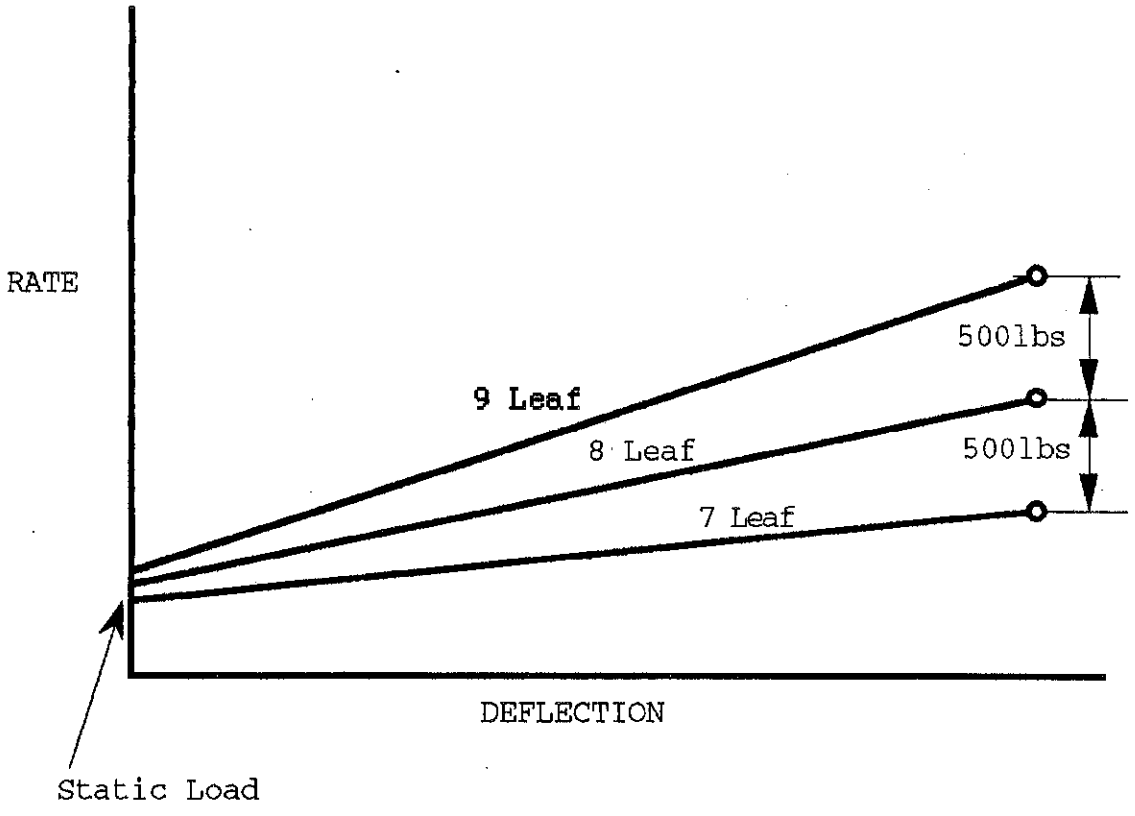
The suspension choice available to new large truck operators has never been greater.The traditional multi-leaf spring is still popular but in a quest for less tare weight , better ride and longer life other types of springs , in both steel and air , have been developed. A vehicle can today be speced for a particular application giving optimum returns over its service life. John and I wish to discuss steel springs and the way shock absorbers can be used to alter their ride characteristics.

Traditional multi-leaf springs are old technology and familiar to any vehicle operator.They have served the industry well and we expect to see their continued use in some applications for many years to come. This is due to the fact that they are easy to alter for a specific requirement.and to repair economically. We would like to briefly outline the working characteristics of a multi-leaf spring.



MULTILEAF SPRING WITH RATE CHANGES SHOWN

You can see from the graph that the spring rate of a multi-leaf spring is fairly linear and that if you vary the number of leaves in a spring the rate will change but the linear characteristic remains the same.It is also possible to tune the rate by altering the lengths of the secondary leaves.This makes the multi-leaf spring very versatile.

JW

The term "shock absorber" is incorrectly applied to the tubular like component between the axle and chassis. It should rightly be referred to as a damper as its main function is to control the motions between spring and chassis.

The load difference for each variation of our spring at full deflection is quite significant , therefore the forces required from a damper must be altered to give the same degree of control. This also applies to the required comfort. For instance if the rebound force of a damper for the seven leaf version is applied to the nine leaf version the overload on the damper is approx. 1000 lbs. If in this case the damper is of the non-adjustable type , and cannot be altered to cope with the increased load of the nine leaf spring after being deflected , it will oscillate three to four times more than the seven leaf spring , and because of the increased resistance of the nine leaf spring, the bump force will be too high and cause the ride to be harsh when negotiating small bumps. Therefore the bump force also has to be altered to retain ride comfort.
Many operators have considered dampers unnecessary with multi-leaf springs due to the inherent dampening effect of the friction generated between the leaves.This is true for some applications but how many roads are there which you drive on are built like freeways where very little spring movement is experienced ?
I would like to show you a short video of an undampened suspension in rough conditions.

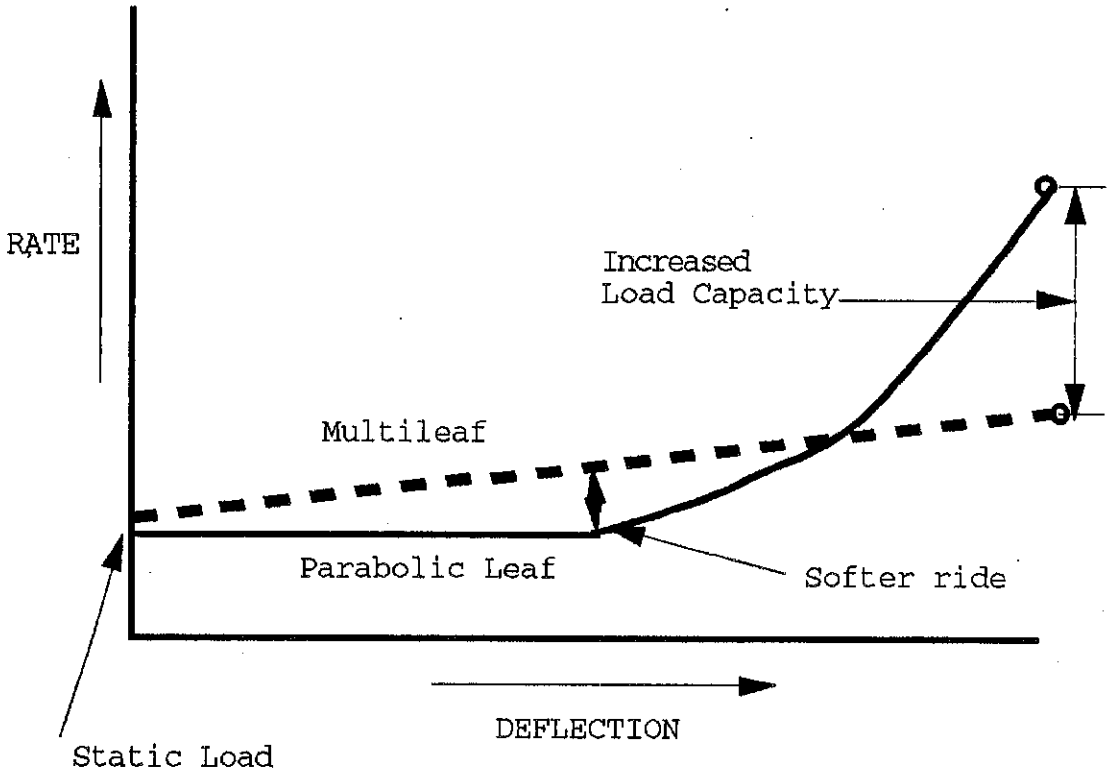
(video Tri 3)

However , in many instances for suspensions using multi-leaf springs substantial improvements to traction , drive-line fatigue and comfort can be achieved by the installation of the correct damper. We now have a video showing a Pacific Logger with an empty triaxle trailer negotiating a one in four gravel road. As you will see without dampers fitted there is considerable wheelspin and axle tramp. With two dampers installed on each drive axle the driver has no problem in moving off without any stress to the truck's suspension or driveline.This degree of control also applies to linehaul trucks when negotiating pot-holes and bumps at highway speeds.

(show Video Hend Damper Kit)

DN

The big trend in recent years for suspensions is to minimal leaf long taper parabolic springs. Multi-leaf springs ,while cheap to produce and easy to repair, have considerable unsprung weight which gives a harsh ride on small bumps. This weight also increases the tare weight of the vehicle thus reducing effective payload. Taper and long taper parabolic springs have been developed since the 1970's to give a softer ride , increase load capacity and , importantly in the case of parabolic springs , increased service life.



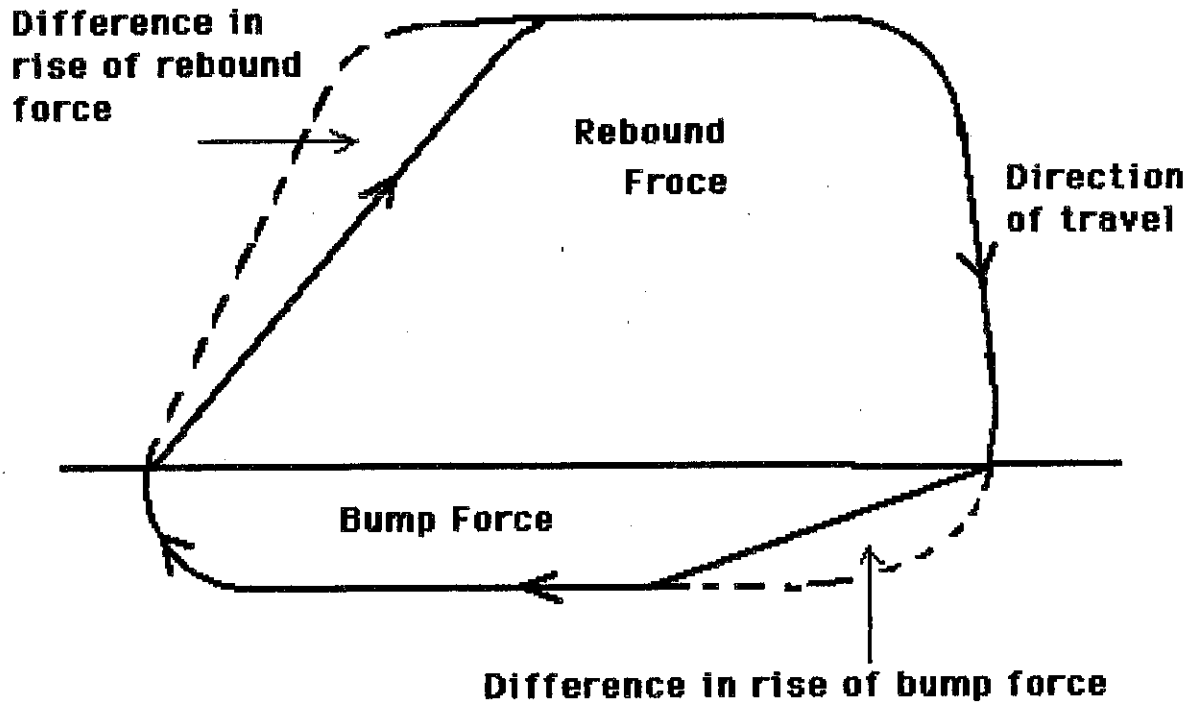
PARABOLIC V MULTILEAF

Parabolic springs are usually designed with only 2 or 3 leaves , with the centre of the spring about twice as thick as the leaf tips. The leaves only touch each other at their centre and tips which enables them to be treated with an effective anti-corrosion process. This prevents failure due to corrosion fatigue prevalent in multi-leaf springs working in corrosive environments. Great attention is paid to the rate of change of the taper as this , together with the length of the spring , controls the rate of progression. The steel used in most European and US

manufactured springs is of special quality made under very controlled conditions producing bar stock with a much cleaner microstructure than normally found in most spring steels. Therefore , under normal road conditions , parabolic springs are able to carry a much higher stress load without the likelihood of fatigue failure. Some vehicle builders are now only offering parabolic springs in their new models. These are proving susceptible to failure were the vehicle is being subjected to heavy duty overload situations. We are currently doing uncompleted test work , under controlled conditions at BHP's Port Kembla Steel Works , with a multi-leaf alternative and a 3 leaf instead of original 2 leaf parabolic spring. To date the 3 leaf parabolic , even though not recommended by the original equipment manufacturer , is giving the best service life under these particularly arduous conditions.

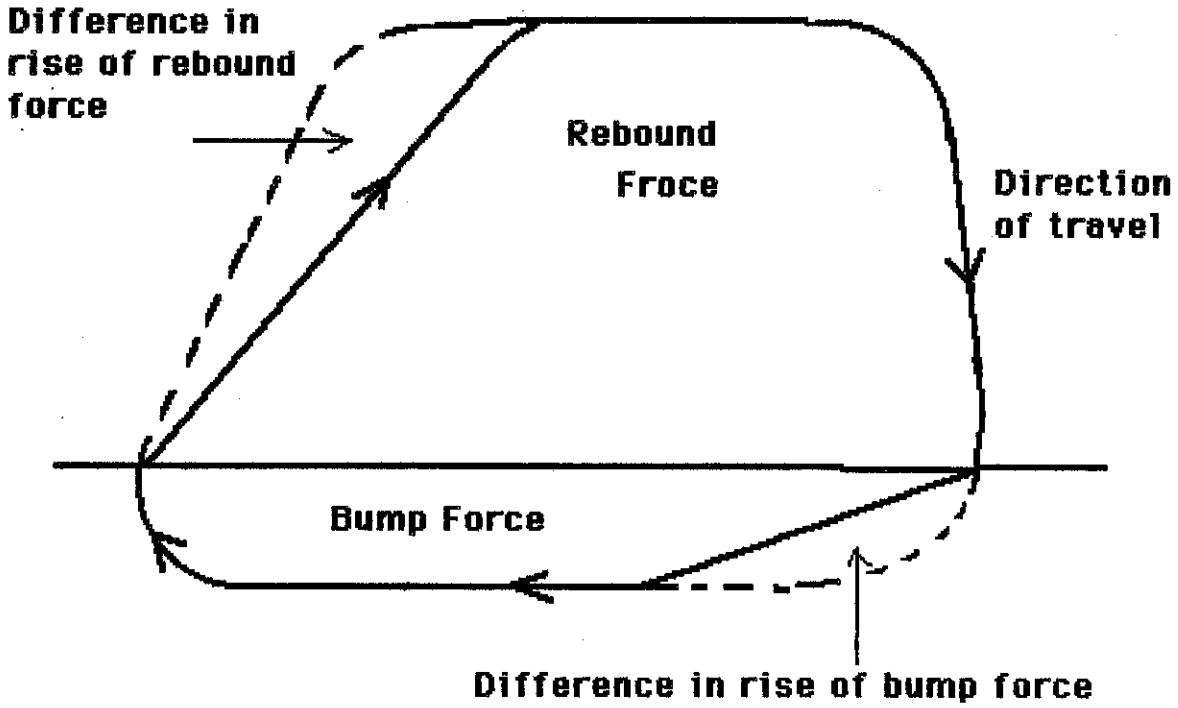
JW

As previously mentioned damper forces must be altered to suit a heavier or lighter rated spring. Likewise you cannot use a damper designed for a multi-leaf spring on a parabolic spring. Spring and damper characteristics are very closely related. I will explain now using diagrams the way a damper can be altered to a specific design requirement.



KONI TEST GRAPH

The rebound forces can be altered to suit the type of spring and the operating conditions. Multi-leaf springs require less rebound force than the parabolic because of the interleaf friction. However , in extreme conditions the degree of rise in rebound force can be much sharper than that required for highway use. This is applicable for both parabolic and multi-leaf.
Bump force for the two types of spring can also vary greatly , except in this case very minor changes to the force of the damper have a major effect to ride comfort and stability.



KONI TEST GRAPH

It has been found through testing that in some cases a very high slow rising bump force gives better performance in off road situations if sufficient suspension travel is available to allow the damper to reach its full force.

(show Tank video discuss rebound control)
(show Commodore Video discuss bump control)

You have seen how the rebound controls the release of stored energy within the spring after compression . The video of the two Commodores is a good example of how the bump force is used to keep the wheel in contact with the road. The spring alone is not sufficient to maintain this contact when small bumps are

experienced. A damper with the correct bump force is the only way to maintain tyre to road contact. Therefore , as described earlier , the correct mount of bump force is vitality important , too much bump force will cause wheel and chassis to leave the ground, too little bump force will cause the suspension to deflect and allow the tyre to leave the ground. If this situation occurs when cornering or braking the vehicle can become hard to handle and loss of control may occur. Added to this is the damage to road surfaces , of which we are all aware , is becoming a major cost burden to Road Transport Authorities.

The next video we wish to show you is from MAN and it clearly displays the degree of efficiency that can be achieved when the balance between spring and damper is correct

(show MAN Video)

Even though the trucks you have just seen have been designed to operate in extreme conditions the same design principles apply to damper and spring for all vehicles relative to their application.

DN

To conclude my part of the discussion I wish to speak about a few simple maintenance items which are sometimes forgotten when leaf springs are replaced. I cannot overstress how important it is that a replacement spring is correctly fitted. The centre section of the spring must be clamped to act like a solid mass of steel. If not , the spring will flex at its weakest point; the centre bolt hole. In this event the spring will fail very quickly by cracking in this position.These simple steps should always be taken.

Firstly , it is important that the spring retention system is in good order. The spring seat and saddle should not be worn , cracked or distorted. If so these parts should be replaced.

Secondly , new U-bolts should be fitted. The reason for this is that if a U-bolt is correctly tensioned the first time the threads on the bolt and nut are deformed. Therefore , if the U-bolt is reused , even though the nut may be correctly tensioned , some of torque will be developed between the nut and the bolt ,(commonly called "pull around torque"), instead of clamping torque (called pull up torque). It is possible to have tight nut but still have loose

U-bolts. Stretching of the U-bolt itself and the threads in the nut is the force which gives the spring its correct retention pressure.

Thirdly , because the new spring stack will naturally settle the U-bolts must be retorqued after a short period of service. Further stack settling will occur as the spring wears so U-bolts should be checked for tightness as part of a routine maintenance schedule. It goes without saying that U-bolts must be made of a suitable grade of steel.

JW

It is inevitable that the quality of your suspension system is ultimately going to effect the running costs of your fleet in more ways than savings in maintenance. What we have attempted to achieve is to advise you that there are companies operating within the industry that can give you advice on long term savings through suspension design and maintenance. We thank you for giving us the opportunity to speak and as manufacturers in the industry we look forward to future involvement with The Institute of Road Transport Engineers.