



## Effect of U-Bolt Tightening to Avoid Earlier Leaf Spring Failures

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### ABSTRACT

*Leaf Spring Failure Analysis: Springs are a limited life component. Spring is one of major suspension part of the heavy commercial vehicle (HCV). The objective of this analysis is to reduce, early leaf spring failure modes by preventive maintenance & servicing of the leaf spring system. The fatigue life study and importance of shoot peening process to increase the life of leaf springs. Regardless of how well a spring is maintained or how favorable the operating conditions are, all springs will eventually fail from fatigue caused by the repeated flexing of the spring. Once the spring life limit is reached a fatigue failure will or has occurred.*

**Keywords : Suspension system, leaf spring, Preventive maintenance, Fatigue life, shot peening**

### Introduction:

To secure reliability, Satisfying required performance during design life of the vehicle, durability of the vehicle components should be generated firstly. Therefore, Vehicle's durability gives priority to analysis and assessment of its endurance under the various environments and loading conditions. In this regards suspension system of the vehicle is very important. The vehicle's suspension system is to protect the passenger and body from the shocks by the vehicle moving over the irregular roads. In this regards suspension system of the vehicle is very important.

The Typical suspension of the vehicle is an extremely complicated system consisting of two leaf springs, four stoppers, two shock absorbers & one anti roll bar.

Among them spring is one of major suspension parts of the vehicle which gives ride comfort in laden and unladen condition. Since suspension system of the vehicle directly influenced to ride and handling, suspension parts should have enough endurance during its lifetime to protect the vehicle system.

The large vehicles need a good suspension system that can deliver good ride and handling. At the same time, the component needs to be lightweight and have an excellent of fatigue life. Fatigue is one of the major issues in automotive component. It must withstand numerous numbers of cycles before it can fail. Or never fail at the all during the service period.

From the viewpoint of engineering application, the purpose of earlier leaf spring failure analysis consists of the probable reason for failure and its remedy.

The aim of this paper is to finding earlier leaf spring failures in middle of the leaf spring stake & individual leaf. Improper service practices adapted in the field for tightening of U-Bolt is one of the critical point due to leaf springs are generally failed in field.

### Types of Leaf Springs failures:

To assure proper spring life, Maintenance and inspection process must include in the service system. In most normal maintenance checks, the spring suspension system is truly

overlooked, but a minimum of attention to the spring suspension would yield a longer and more reliable suspension system service.

To avoid premature failure of leaf spring we need to understand different types of leaf spring failure modes and analysis of each failure why these premature failures are occur in the field in early kilometers. An Important points which will affect the failures.

### Leaf spring failure modes and its analysis:

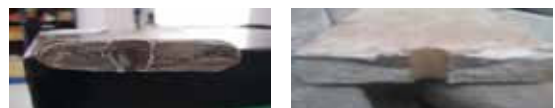
Generally three types of failure occur in the heavy commercial vehicle.

- 1) Whole stake fails from centre.
- 2) Individual leaf fails from centre.
- 3) Individual leaf spring fails from other location.

Some of the premature failure happened in the field in heavy commercial vehicles.



**Fig.1- Whole stake failed from centre**



**Fig.2 - Individual leaf spring failed from centre**

### Leaf spring failures:

Improper maintenance practices can reduce fatigue life of leaf spring. For example, Improper retightening of U-Bolt nut, in regular interval may one of major cause of earlier failure of leaf spring from centre & other location.

**U-Bolts Nut Tightening:**

Operators of large fleets of trucks and buses have found that center breakage of springs is greatly reduced by "retightening" U-bolt nuts-after the first days run-when a spring has been repaired or replaced. There are a number of surfaces between the leaves which bed down a little during the first day's operation. But retightening takes up the resulting slack and the spring then remains tight for a longer period.

**Nuts may be tight while bolts are loose:**

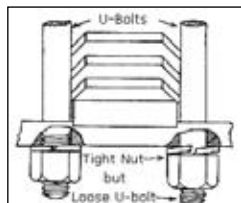
When in doubt as to whether the U-bolt nuts are really clamping parts together tightly, a sharp "rap" with a hammer will sound the answer.

Further retightening, of new or repaired springs, is suggested at the end of the first 250 Hrs, after 750 Hrs. and on appropriate intervals determined by individual preventive maintenance plans. Failure to retighten the U-bolts may lead to serious damage to the suspension system or serious injury or death to the vehicle operator.

When a U-bolt has been torque to its recommended torque level, the bolt and threads will stretch to mate with the deep nut. Because a properly installed U-bolt is stretched, it becomes apparent that the U-bolt should not be reused in repair. The stretching action on the threads will distort the threads enough to achieve a type of cross threading when the nut is removed. This action will tend to cut new threads as the nut is removed, thus lowering the U-bolt's ability to clamp by specified torque.

**U-Bolt Nut tightening procedure:**

Lubricated U-bolts & Nuts must be used to reduce the coefficient of friction in-between U-Bolt & Nut. Tighten high nuts in the sequence shows fig-3 to approximately one third of the recommended torque.



**Fig.-3**

Gradually tightening the U-Bolts cannot be stressed enough. If one of leg of a U-Bolt is fully torque before the other leg is tightened, the U-Bolt will stretch and either upon installation or shortly after it is on the road.

Proper torque is the key element of suspension performance, Leaf spring and component life, and vehicle reliability.

U-Bolts perform very important role in suspension system.

- Provide a positive clamping force between top plate, Leaf spring, Axle seat and axles.
- Provide 'flex' point for spring away from centre bolt area.
- Keep spring pack tighter eliminating shearing of spring centre bolt.

The U-bolts must be tightened to the proper torque specs to eliminate any movement between the spring and the axle and between each leaf of the spring. If the U-bolts be loose, two things can happen—broken center bolts and broken leaves. When installing new springs be sure to use new U-bolts. Attempting to re-use the old U-bolts may be harmful for the suspension system.

Some elongation occur when U-Bolts are installed and properly torque. This elongation helps maintain the correct clamping force. Because of this a used U-Bolt will be unable to produce required clamping force.

Lab results say Dacromat finish U-Bolts reuse only one time but to achieve desired pre load need to replace new Nut at the same time.

**Table1. Torque V/s Pre load measurements of Reused Dacromat finish U-bolt & Nut using 1st time**

Applied Torque (Nm)	Pre load (Nm)				Remarks
	Leg 1	Leg 2	Leg 3	Leg 4	
800	251	246	249	250	New U-Bolt & Nut
800	201	186	200	207	Pre load achieved by Reused U-Bolt V/s Reused Nut (1 <sup>st</sup> Time)

**Table2. Torque V/s Pre load measurements of Reused Dacromat finish U-bolt & New Nut using 1st time**

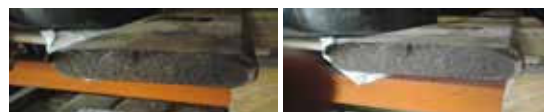
Applied Torque (Nm)	Pre load (Nm)				Remarks
	Leg 1	Leg 2	Leg 3	Leg 4	
800	221	220	235	225	New U-Bolt & Nut
800	234	217	218	220	Pre load achieved by Reused U-Bolt V/s New Nut (1 <sup>st</sup> Time)

**Individual leaf spring fails from other location:**

There are so many causes for individual leaf broken from other locations, but U-Bolt loosening is one of the major reasons for leaf spring failure in other locations also. The U-Bolt keeps the leaf spring clamped solidly in to place. U-Bolts must be torque properly at all the time to keep the leaf spring from flexing within the axle connection area.

The proper tightening of U-Bolt is critical to the leaf spring suspension. Loose U-bolts are the leading cause of misalignment, spring breakage and premature failure of other related parts. Normally in bogie suspension the U-bolt high nuts are torque to much higher value than those in any other designed leaf spring suspension. Using an air impact wrench to torque the high nuts usually will not give the torque required. A torque wrench and multiplier must be used.

The center bolt is necessary to hold all the leaves together and to locate the axle in correct position. The axle is located by the center bolt head that fits into a hole in the spring seat. Then the U-bolts are used to bind the spring and axle into one unit.



**Fig-4- Individual leaf spring failed in other locations**

Correctly manufactured springs, leaf springs are shot-peened, which removes stresses in the metal which occurs during the heat-treating process. The life of the spring is not only increased because of shot-peening, but the spring will not continue take "a set" once it is installed. Even after shot peening some of the individual leaf springs are failed in early kilometers.

Normally without shot peened heat treated leaf springs are having negative compressive stress in the range of below 200 Mpa. The negative compressive stress will not give any advantage about life.

The shot peened leaf spring is having the negative compressive stresses in the range of 350 to 450 Mpa. This range will give better results and the life of the spring will be increase by 2 to 3 times as compare to without shot peened leaf spring.

Improper tightening or loosening of U-bolts is one of the reasons for individual leaf spring failure. Loosening of U-bolts is creates a gap between two spring leaves during vehicle running and at the same time a sharp foreign particles inserted

between the gaps and developed point contact load locally. Due to these phenomena, a high stress is developed near the sharp edge contact area on leaf spring top surface and small cracks are developed over the leaf spring surface.

After few kilometers of vehicle running, cracks will further increased and at the time of impact loading, individual leaf springs got fractured near point contact area.

#### Conclusion:

Improper maintenance practices can reduce fatigue life of leaf spring. Improper retightening of U-Bolt nuts, in regular interval may one of major cause of earlier failure of leaf spring from centre & other location.

The U-bolts must be tightened to the proper torque specifications to eliminate any movement between the spring and the axle and between each leaf of the spring. If the U-bolts be loose will one of the causes of leaf spring stake failure or individual leaf failure from the centre.

When installing new springs, be sure to use new U-bolts &

Nuts. If using Dacromate finish U-Bolts, then reuse one or two times based on quality of U-Bolts. But do not reuse Nuts at the same time. Always insured that use new Nuts during installation of leaf springs.

Any leaf spring system clamping force is required to hold all the leaves in proper manner. Re-use attempting to re-use the old U-bolts may be harmful for the suspension system.

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