. Introduction:

Leaf spring also called a laminated spring or semi elliptical spring or cart spring which is oldest form of spring dating back to medieval time. The end of spring guided along fixed path if performance of spring is considered with helical spring. The spring has rectangular cross section area which can be altered to parabolic or elliptical as per the requirement. Centre arc provide location for axle, tie holes provided on either end used for spring to attach to vehicle body. The leaf spring can made from single leaf or it may be the combination of various leafs, bent for definite radius and stacked one above the other. Like the bending radius length of leafs stacked one above the other also varies as per the requirement of application. For heavy vehicles generally multi-leaf spring is used, where for light weight vehicles mono leaf spring is preferred now days. The damping action is served by inter leaf friction between mated leaf. The flat leaf spring usually flattens on the application of load and dissipates the absorbed energy to surrounding in different forms. Leaf spring either attached to frame at both ends or attached directly at one end and other end attached through shackle. Shackles takes up tendencies to elongate when compressed and thus assisting spring to perform its job in superior manner.

The leaf springs are of type, Elliptical, Full Elliptical and Non Elliptical etc. apart to these, spring can be used in different formats and few of such are discussed below,

1. Ford Model has multiple leaf spring
2. Coil spring/Helical spring
3. Mono Leaf spring etc.
4. Parabolic leaf spring (Thickness varies from center to eye end, spring leads to produce interleaf friction)
Fig (1): Basic spring leaf model used in heavy duty and light duty vehicles in the form of suspension system [38].

Leaf springs are used in heavy and light duty vehicles; the flat leaf spring speared the load over vehicle chassis, where, helical leaf spring transfers the load at single point. Leaf spring eliminates the need of arms, a pan hard rod and thus saving cost and weight both. The parabolic leaf springs are more flexible and impart the maximum driving comfort and safety on irregular road conditions. Parabolic springs used in buses.

Fig (2): Conventional Multi-leaf springs used in light duty vehicles [29].

1.1 Working of leaf spring: It truck suspension if rigid its wheel will left the road after heating up’s and downs, the good and flexible suspension system retains the road contact even road conditions are typical. It absorbs the thrust, shocks, impact and vibration and dissipates to surrounding in the form of heat and sound energy. The leaf spring is treated as beam of uniform strength for the purpose of its behavioral analysis. The longest blade is provided with eye and many smaller blades of varying length are attached below to it. The longer blade is called as Master leaf, where, the remaining blades are called as Graduated Leaves. All blades are bound together by Steel Strap. The front end of spring is connected to frame where rear end is connected to shackle. The leaf spring is mounted axle of vehicle, and entire load of vehicle is rested on spring. Shackle is flexible link which connects between frame and rear eye, when vehicle come across up’s and down, the spring deflects and distance between two eyes changed to accommodate the impact of road irregularities.
1.2 Objectives of the suspension system: Any suspension system is generally designed keeping in mind following objectives,

1. To prevent road shocks and being transmitted to components of vehicles and passengers seating inside of it.
2. To ensure driving stability and comfort.
3. To avoid mishaps that tends to occur due to vertical loadings, shocks and vibrations etc.

It has been observed that frequency and amplitude of vibration goes rising with respect to severe road conditions, and thus it reduces passengers comfort and safety both. The amplitude of vibration turned to reduce riding comfort and stability, the few of the parameters adds severity to the amplitude of vibration and can be listed as, side thrust, un-sprung weigh, rolling etc. Few of the popular suspension systems to enhance the effect of comfort, stability and safety which are popularly used in vehicles can be listed as, plastic suspension, independent suspension, wishbone suspension, strut type suspension, vertical guide, trailing link suspension, interconnected suspension, air suspension, half axle suspension, hydro elastic suspension etc. [1]

Focus of reducing weight and increasing the efficiency have attracted an attention of researchers in the field of material use and optimization, as a result of so many years efforts investigated, composite could use to advance extent in the process of design and development of leaf spring [2,3]. Every innovation is bring forth with use of new material, and use of Nano-particle is one such innovation which is commercialized successfully nowadays [4]. Use of composite material such as carbon epoxy, Glass/Epoxy is gaining popularity now days due to innovations happened in the domain of material optimization and use for different application [6]. The efforts of making composite leaf spring for light weight vehicle as a replacement for conventional steel have executed and implemented successfully [9,14]. The study of fatigue behavior analysis of leaf spring by laboratory method helping designer to alter the design and invent it in most optimized way to increase the life of leaf spring [29].

The exact forecasted life of composite spring used in heavy duty trucks is evaluated by laboratory method successfully; it helps designer to understood performance affecting parameters and thus need of improvement at various fronts [27]. Geometry and thickens of spring are performance affecting
parameters which can be put forth for optimization, successful process of optimization leads to save on time, cost and material [32].

Fig (3): Fatigue life assessment of leaf spring by Laboratory Method [38].

To reduce size and shape of spring, multi-leaf springs are now days replaced with Mono-Leaf spring whose performance is superior to conventional leaf spring [35]. The optimized design of leaf spring is now days implemented in Solar Vehicles, US Defense Vehicles which is designed to carry the load of 5 Tons [4]