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Axle Path Generation of parabolic leaf spring by Using Two Point Deflection Three Link Mechanisms

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ABSTRACT

The principle of this an analytical method is based upon the use of the parabolic leaf spring two cantilever deflections corresponding to a given deflection at the center of the spring seat. These deflections may be computed for vertical positions of the spring seat, for maximum compression (metal-to-metal), curb weight and maximum rebound. When they are applied to the three-link Equivalent of the spring with main leaf in the flat position, the path of the axle and the angle of the spring shackle can be determined entirely construction by using kinematical modeling.
Advantage of this method Preparation of complete parabolic leaf spring envelope sway bar, shock absorber, rear axle stopper. Accurate location of wheel center position at different loading conditions. Spring seat angle calculation.Shock absorber length & angle calculation. Rear axle pinion inclination.

Keywords- ***Axle Path, Leaf Spring, Parabolic Leaf Spring, Suspension.***

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I. INTRODUCTION

This method has the advantage that all of the layout work can be done within the overall length of the spring. In cases where the unsymmetrical factor is small and the zero point is far from the axle center, it is the only known procedure which permits construction within the confines of the standard layout board and straight edge. The principle of this method is based upon the use of the two cantilever deflections corresponding to a given deflection at the center of the spring seat. These deflections may be computed for two vertical positions of the spring seat, for example maximum compression (metal-to-metal) and maximum rebound. When they are applied to the
Three-link equivalent of the spring with the main leaf in the flat position, the path of the axle and the angles of the spring seat can be determined entirely by construction.

- Plotting of axle path in Pro-E by using kinematic modeling.
- Preparation of complete rear suspension (leaf spring) envelope, Sway Bar, shock absorber, rear axle stopper.
- Location of wheel center.
- Shackle & spring seat angle calculation.
- Shock absorber length & angle calculation.
- Rear axle pinion inclination.

II. PARABOLIC LEAF SPRING

Basically a Parabolic Spring is a spring that consists of two or more leaves. The leaves touch only in the center, where they are fixed to the axle and at the outer ends, where they are fixed to the vehicle. In between those two points the leaves do not touch each other as they do with conventional leaf springs.Each leaf represents a complete spring in itself and will act as such. To enable this leaf is tapered, from the center (thick) to the outer ends (thin). This tapering is parabolic, it means that every centimeter (or inch) the thickness of the leaf decreases in an amount that relates to the square function of its length.

Every single leaf will have, more or less, the shape of a complete multi leaf spring and thus it's capable to cope with the same forces. This means that the ideal parabolic spring could have only one leaf, however, Parabolic spring will have very limited articulation/weight ratio due to high internal stresses so a 2 or 3 leaf parabolic spring can divide the stresses more evenly across the other leaves and thus more axle movement is possible. Another reason to increase the number of leaves on a parabolic spring is to increase the rate (load capacity). Because every leaf is one spring can add or take out leaves without compromising the strength of the leaf itself.

Here are advantages of parabolic leaf spring

- Reduce spring stiffness to improve ride quality.
- Improve ride by reducing interleaf friction.
- Reduce Spring Weight.

Increased Spring Life.

III. DEFLECTION THEORY

As a spring with leaves of parabolic in section properly stepped to approach the condition of uniform strength is deflected, it will assume the shape of a circular arc at all loads between zero and maximum, provided it has a circular arc shape or is flat at no load or at any given load.

Most springs approximate these conditions closely enough so that the circular arc shape can be used to calculate their geometric properties. The following relations have been derived analytically and found to agree closely with a number of actual springs checked.

This type of spring can be considered as two cantilever springs, and the resulting spring action can be determined by considering the spring as a three-link mechanism, as shown in Figs. 1 These layouts can be drawn even if the spring is unsymmetrical and if the eye offsets are opposed. The three-link equivalent layouts are useful in determining the geometry of spring action, including the path of the axle attached to the spring seat, and the axle control which is defined as the seat angle change in degree per millimeter of deflection. They also permit establishing the axle path and control corrected for the shackle effect.

IV. BASIC STEPS BEFORE PLOTTING AXLE PATH

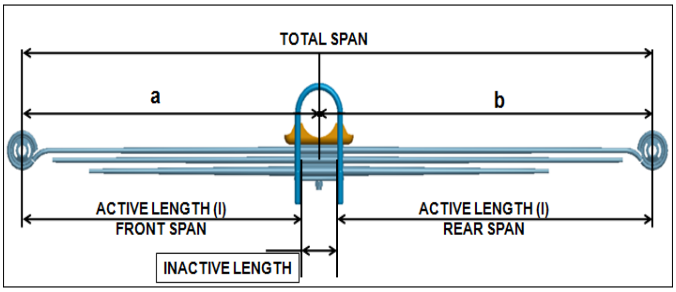

Fig 1: Nomenclature of Parabolic Leaf Spring Flat Condition.

1. Start layout with main leaf in flat position with length a & b.
2. Draw a line passing through spring eye center.
3. Calculate active length for front & rear span.
4. Draw front /rear arc from spring eye center.

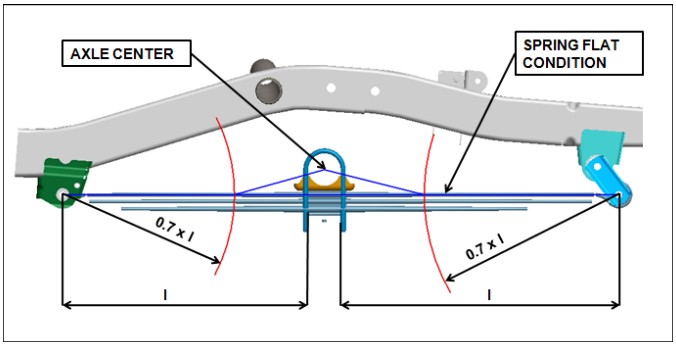

Fig 2: Arc method leaf spring flat condition.

5. Draw triangle by using axle center and intersecting points of curve spring center line passing through eye center.

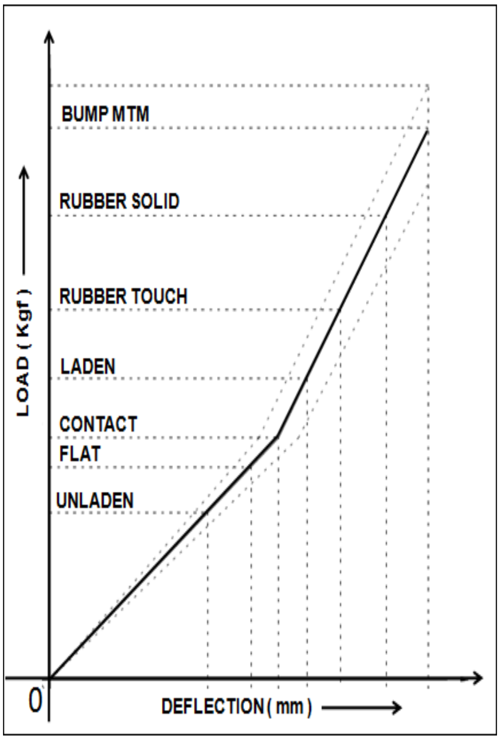

Fig 3: Typical load deflection graph

6. For given deflections graph such as rebound (Xr), unladen& laden compute front and rear span deflection (F) from the following formula.

If X =Rebound

Ff= Deflection at front span

Fr= Deflection at rear span

a= Front span

b=Rear span

Deflection at front span

Ff=X (a/b)

Deflection at rear span

Fr=X (b/a)

7. Take spring free camber as spring rebound condition calculates deflection at front/rear span.

8. Draw arcs with radius equals to deflection at front and rear span.

11. Follow the same procedure for unladen condition.

12. Draw arc by using 3 points from flat, rebound, unladen conditions triangle.

The control in degrees per millimeter is equal to theangular change in the position of the center link dividedby the deflection. In the unsymmetrical spring the control is zero, withthe center link moving parallel to itself throughout thecompression and rebound range. Actually, however, thecenter link undergoes a small angular change due to thevertical displacement of the shackled spring eye. Depending upon the accuracy demanded of the layout,a correction for the effect of the shackle may benecessary, particularly when the shackle angle is exceptionallysmall less than 60 deg in the flat main leaf.

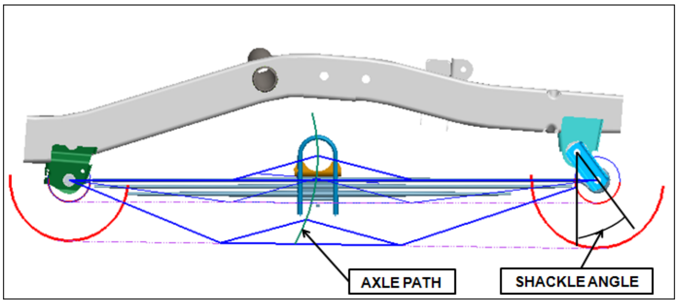

Fig 4:Actual axle path for three conditions.

V.CONCLUSION

A study is done for axle path generation of parabolic leaf spring. Based on the requirement of leaf spring suspension of light commercial vehicle.From analytical calculation of Parabolic leaf spring travel& plotting of axle path suspension wheel centre & leaf spring deflection can be calculated.

From Load deflection of parabolic spring different loading conditions & wheel centre position can be optimize by using axle path. This method consider in leaf spring suspension design & optimization by using pro-e kinematics modelling. Also useful in wheels envelope generation by placing wheels at different wheel center positions.The research work can be extended to theanalysis of stress in parabolic leaf spring at different loading conditions.

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