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Leaf Spring FE Model Creation using TCL/TK Scripting

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Abstract: Leaf spring (elliptical) is the component used in the automobiles to reduce the vibrations coming on the vehicle. While doing FEA it is important to create finite element model of the leaf spring quickly and accurately. This can be done by doing scripting in TCL-TK i.e. tool command language. Analysis software used for this is hypermesh and coding language of hypermesh is tool command language. Automation done to build the FE model of leaf spring leads to improve the efficiency and reduce the process runtime. This reduction in the process runtime ultimately results in the cost saving.

***Index Terms*: Leaf Spring, Hypermesh, FE Model, Automation, TCL/TK Scripting.**

I. INTRODUCTION TO LEAF SPRING

Leaf springs are an integral part of your vehicle's suspension system. Leaf spring helps to support the entire weight of your vehicle. Also helps in maintaining the grip of tyre on the road. regulate the wheelbase lengths when it is speeding up or slowing down. leaf springs plays an important role in controlling the height of the ride and axel damping. There are many types of leaf springs as, semi-elliptical spring, quarter elliptical spring, transverse elliptical spring etc. In the commercial vehicles, mostly elliptical type of leaf spring is used.

II. INTRODUCTION TO FEA AND TCL/TK

A. Finite Element Analysis (FEA):

Finite Element Analysis is the simulation of physical phenomenon done using the numerical technique called Finite Element Method (FEM). There are mainly three steps in the FEA and those are,

a) Pre-processing
b) Analysis
c) Post processing

Pre-processing includes geometric modelling, meshing, applying loads, boundary conditions, constraints etc. In analysis step, FEA model is analysed using proper solver for the required results. Solvers can be Nastran, Ls-Dyna, Abaquas etc. In post-processing step, actual stress and displacements review is done.

B. Tool Command Language (TCL/Tk):

Tcl (Tool Command Language) is the dynamic programming language, suitable for a very wide range of uses, including web and desktop applications, networking, administration, testing and many more.
Tk is a graphical user interface toolkit that enhances the desktop applications level over the conventional approaches. Tk is the standard GUI for many other dynamic languages.
Coding language of hypermesh is Tool Command Language. Hypermesh also has its own group of commands, like,
a) Tcl GUI Commands: Operate on the Hypermesh GUI widgets.
b) Tcl Modify Commands: Used to modify the hypermesh database
c) Tcl Query Commands: Get data from the hypermesh database
d) Utility Menu Commands: do documentation on the commands that control the Utility menu in the hypermesh

III. LEAF SPRING BUILDING: MANUAL METHOD

Below image gives the methodology of building FE model of leaf spring manually.

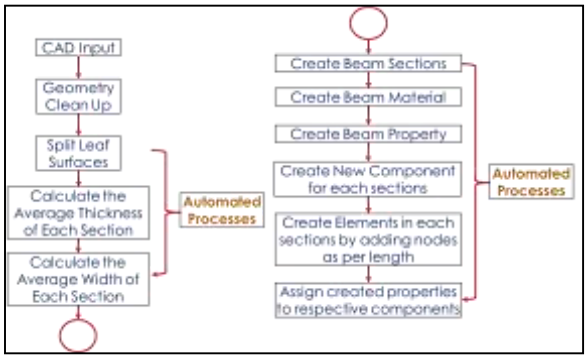

Figure1: Manual Methodology

a) CAD Input: Review the received input CAD geometry of leaf springs
b) Geometry Clean-up: Do the geometry clean-up if required. This is optional step.
c) Split Surfaces: Split the surfaces in the smaller sections. It effects the accuracy of model built.
d) Calculate Average Thickness: Calculate of average thickness for each sections.
e) Calculate Average Width: Calculate of average width for each sections
f) Create Beam Sections: beam sections are created using calculated thickness and widths
g) Create Beam Material and Property
h) Create Component, Add Elements and Assign Properties.

Smaller the sections of leafs greater the time required for the FE model building.

IV. LEAF SPRING BUILDING: AUTOMATED METHOD

Below image gives information about the automated leaf spring building.

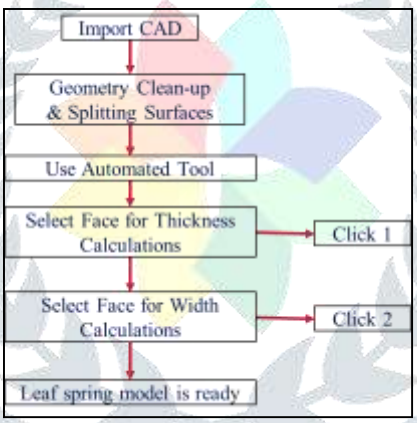

Figure2: Automated Methodology

First two steps i.e. CAD Input and Geometry clean-up steps are common in manual and automated processes. After geometry clean-up we have to use the developed script/automated tool.
While using automated tool, we just have to do only 2 clicks, one is for thickness calculations and second is for width calculations. All further processes are automated.

a) Thickness Selection: automated tool will ask us to select the thickness surface first for the thickness calculations. If there is change in plane of thickness surfaces, select one surface on each plane.

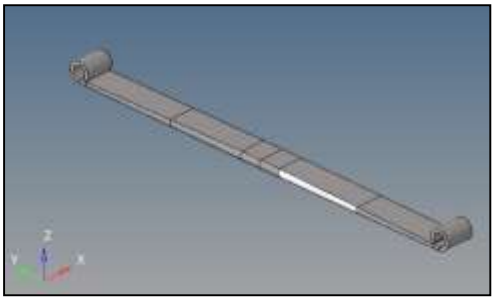

Figure3: Thickness Selection

b) Width Selection: Second selection is to select width of leaf. We just have to select one surface for width calculations.

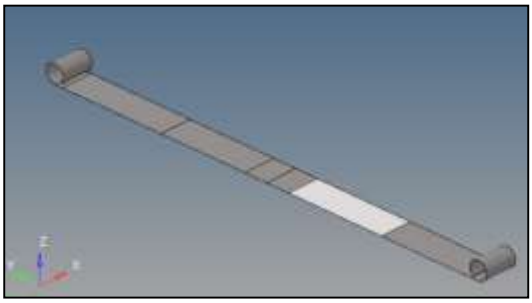

Figure4: Width Selection

V. PROCESS COMPARISON

Below figure gives the comparison between manual method and automated method. As we can see there many steps need to be followed in manual method. But in case of automated method, there are only two steps import the CAD and do the geometry clean-up. After the just use the automated tool to build leaf spring.

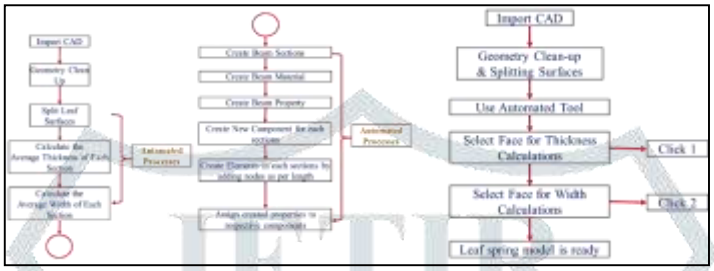

Figure5: Method Comparison

Manual method required 2hrs i.e. 120mins to build one leaf spring. With automated method leaf is modelled within 2mins/per leaf. So if there are 10 leafs are there it will take 20mins. That means there is time saving of 100mins.

$$\%\text{Time Saving} = \frac{\text{Manual Time-Automated Time}}{\text{Manual Time}} * 100$$

Time Saving				
Sr. No.	**Method**	**Time Required (in min)**	**Time Saved**	**%Time Saving**
1	Manual Method	120	100	83.33%
2	Automated Method	20		

Table1. Time Saving Comparison

There is time saving of 100min and in terms of percentage time saving is 83.33%. This time saving leads to cost saving as well.

VI. CONCLUSION

1) Automated method leads to error-free FE modelling. It reduces the process runtime.
2) Use of automated method leads to time savings of 100mins.
3) Percentage time saving is about 83.33% and is considerably high.
4) Time saving ultimately leads to the cost saving

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