Concept Evaluation and Optimization Tool for Rear Twist Beam Axles

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ABSTRACT

The RTB-Toolbox presented here is an innovative software dedicated to the optimization of Rear Twist Beam (RTB) performances, namely Roll Over Stiffness, Kinematics and Compliance.

First of all, the beginning of the project was not only the understanding of OEM requirements for RTB with several physical tests, but also the ability to create a simple model which is precise enough to evaluate these requirements in order to answer them the fastest possible.

The first main idea of the software development presented here leads to a process creating a model in ten minutes which runs in five minutes, changing the traditional approach CAD/CAE iterations. The geometric construction of the RTB leans on a library of sections with user-defined dimensions, using a graphical intuitive interface.

The second main idea was the automatic parametrization of the CAE model in parallel of its creation, giving the possibility for users to take in account many HyperMorph shapes. It results in an automatic HyperStudy file letting the choice among launching the nominal model, optimizing it or creating a Design of Experiments.
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Our products

- Body in white
- Instrumental panel cross car beams
- Other parts
- Pedal units
- Chassis
Problem: twist beam and loadcases

Loadcases description:

- **Roll Over Stiffness**
- **Kinematics**
- **Compliance**

Responses:

\[
ROS = \frac{(\Delta F_{zag} - \Delta F_{zad}) \times Y_{ad}}{Arctg(\Delta Z_{ad} \div Y_{Ad})}
\]

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Strategy: Acquisition of several twist beams from different classes A, B, C

- Acquisition of several twist beams from different classes A, B, C
- Physical tests
- Roll Over Stiffness, Kinematics & Compliance results must be similar
HyperMesh Process

**Geometric data**

- **Arm**: entry file import, create sections along line, morphing, meshing
- **Beam**: create line, create sections along line, morphing, meshing
- **Anti Roll Bar**
- **Shapes**: creates automatic morphing shapes ready to use within HyperStudy
- **Wheel plates**

**Exported data**

- **Modeling**: generates an Abaqus file ready to run and all the files needed to launch an optimization …

**Development**: Tcl / Tk (graphical windows), for HyperWorks 8.0 and 9.0

**Objectives**: generate very quickly (a few minutes) an Abaqus file

...generate all HyperStudy files for optimization
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**Import the entry file**

Entry text file contains:

- A list of points defining arm’s generative line
- OEM datas:
  - coordinates of all fixed points (bushings, springs, wheels)
  - stiffnesses of all (bushings, springs)
- Technical specifications (= optim. constraints):
  - Roll Over Stiffness
  - Toe & Camber for all loadcases

The result is the creation of a line passing by entry points drawed above, in both XY plane and XZ plane.

OEM datas (bushing, spring and wheel plate) also appear but remains fixed.

These points can be modified on the graphical window with automatic update of the line.

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**Creation of the arm sections:**

Creates a user-defined section among the 5 existing, along the generative line.

Existence of a library file permitting the adaptation of an existing arm into a new environment.
Modification of the arm sections:

- Morph volumes and sections shapes are automatically created.

Automatic Meshing and reflexion of the arm:

- 8 types of modification for each section.
Creation of the beam sections:

- User-defined section with variable number of points
- Interaction between HM panel and TK graphical windows
- «Classical» beam section
- Existence of a library file permitting the adaptation of an existing beam into a new environment
Automatic meshing of the beam:

- Mesh Size = 8mm (run in ~ 5 mn)
- Automatic remeshing of extremities
- Registering of all beam sections parameters in a text file which can be added to the library file for future use of this beam

Possibility to add an Anti Roll Bar:

- ARB is meshed with 1D-elements
- The bar can cross one or two side(s) of the arm
- Automatic remeshing around holes

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**Automatic Shapes:**

A « network » of morphvolumes is generated around arms and beam, and creates 4 shapes for the beam and 2 shapes for each arm’s section:

- Beam translation along Z
- Beam heigh
- Arms sections - heigh
- Beam translation along X
- Beam width
- Arms sections - width

Shapes can be combined in order to avoid a too high number of variables for optimization

**Variables exported for optimization:** 6 morphing shapes + all parts thicknesses (+ bar diameter if ARB exists)
**Creation of wheel plates:**

Wheel plate is modelized by a rectangle with possible adjustable edges.

**Next steps:**
- Modeling (properties, clean up, OEM datas, ...), creation of loadsteps, loadcollectors and outputblocks in order to run the Abaqus model.
- Optional combination of existing shapes, and adjustment of shapes in fixing new boundaries into a specific environment.

**Exported files:**
- *.inp (Abaqus model)
- *.abaqus.node.tpl, *.shp, *.tpl (param. files for HST)
- *.xml (HyperStudy File)
- *.bas (Excel macro after DOE’s Response Surface Export)
Optimization Process

HyperStudy file generated with nominal run ready to run, with variables and responses already created for DOE.

- **Nominal run**: Abaqus file, Variables at initial state
- **DoE**: Number of runs depends on number of variables selected
- **Approximation**: generates a response surface
- **Optimization**: Obj: Minimize Mass, Constraints: respect OEM requirements written in the entry file + VM Stress objective

DoE post-processing on HyperStudy DSS

- **Response Surfaces**: Roll Over Stiffness, Toe and Camber for Kinematics and Compliance, Von Mises Stress for Kinematics
DoE post-processing on HyperStudy DSS

- Influence of each parameter on responses:

- Influence of combined parameters on responses

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Optimization with HyperStudy from Response Surface:

Response Surface is exported in Excel from HyperStudy:
Parameters can be modified with automatic update of responses and changes the cell color (green/red) in relation with technical requirements defined in the entry file.
Excel solver is initialized (objective and constraints) and ready to execute.

Optimization is based on the response surface.
CONCLUSION

The RTB-Toolbox allows a full « conception + optimization » cycle every day
Questions?

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