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General Remarks

This documentation chapter describes some available tools for the *FTire* model family. For more material about *FTire*, and other tire simulation tools, please visit www.cosin.eu.

1 Modal Analysis

sorry, this documentation chapter is not yet available.

2 Static Analysis

sorry, this documentation chapter is not yet available.

3 Steady-State Analysis

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4 Linearization

sorry, this documentation chapter is not yet available.

5 RoadVisualizer

sorry, this documentation chapter is not yet available.

6 Data Estimator (FTire/estim)

This tool will generate ready-to-run *FTire* data files, even if only very few data are available.

The idea behind this is to use a validated data file for a representative tire size of the same category (called the **reference** tire). The sizes and load/speed ratings (and certain other basic data, if available) of the tire to be estimated are compared to the respective values of the reference tire.

The relative changes of these values are fed into certain estimation formulae. These formulae describe assumed dependencies between the well-known changes mentioned above, and unknown changes of physical properties like stiffness and modal data, as needed for *FTire* parameterization.

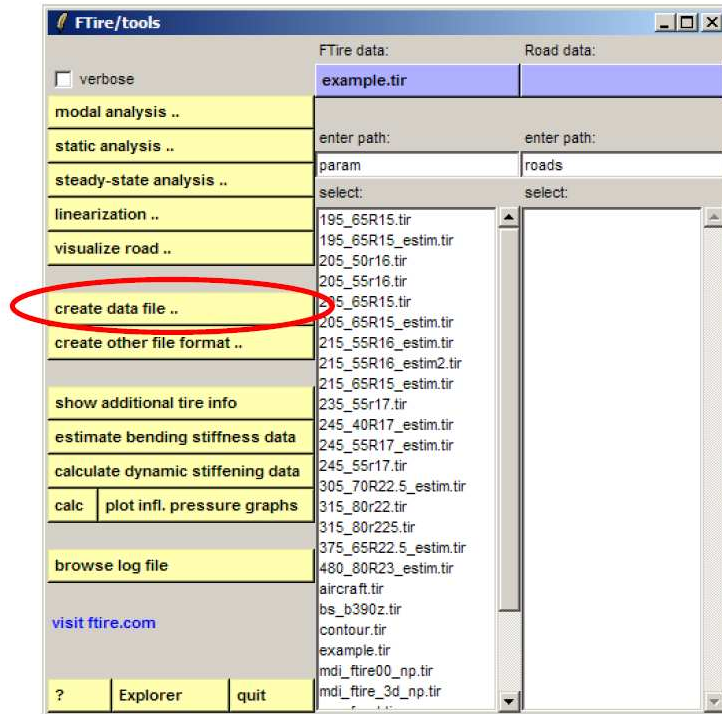
Of course, such an approach yields nothing but a first guess of *FTire* data. It can never replace a proven (and expensive) measurement procedure. Rather, it is meant as a simulation tool to study, in principle, the impact of changes in tire size to the vehicle's handling and ride characteristics.

No warranty, neither explicitly nor implicitly, is given that *FTire* data files, generated by this estimator, are sufficiently accurate to being used for whatever simulation tasks.

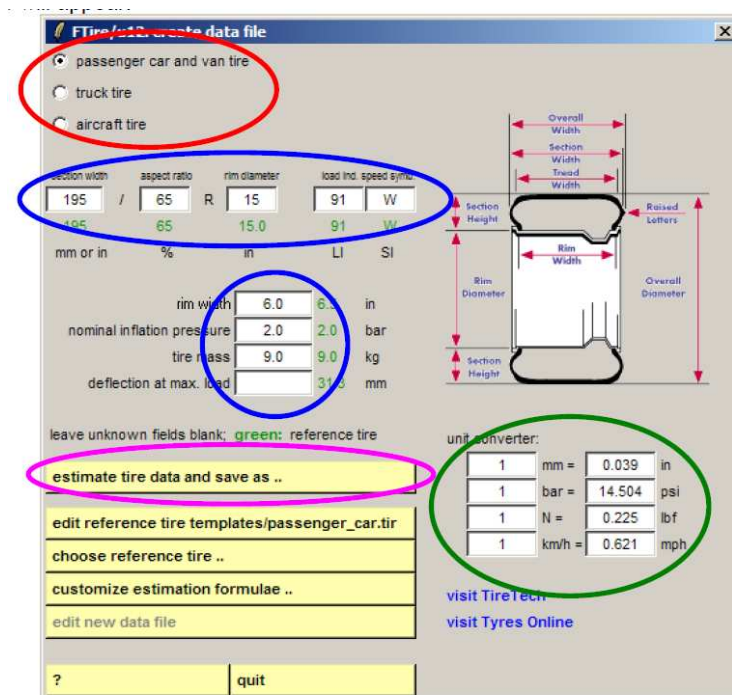
An important feature of the tool is the ability to being customized. Both the reference tire and the estimation formulae can be easily defined and altered by the user.

6.1 Creating Data Files

The data file estimator is being invoked by clicking 'create data file ..' (red ellipse) in the *FTire/tools* menu:



This window will appear:



First, you should choose the **tire category**. Basically, the category will define the default reference file to be used, and certain other default values. The respective 'radio buttons' are marked with a red el-

lipse. Depending on this choice, certain green values will appear or change at different places of the menu. These are values which belong to the reference tire, and which are automatically updated if they change.

At present, the following tire categories are provided:

- passenger car tires (including vans)
- truck tires
- aircraft tires

Clearly, this categorization does by no means cover the wide field of available tires. Among others, bicycle tires, motorcycle tires, ATV tires, race tires, agricultural tires, heavy machinery tires, etc. are not yet present with own reference data files. However, it is intended to extend the list of categories as soon as respective sufficiently validated reference files are available.

Next step in the process of generating a new data file will be to enter those values of the new tire which are well-known (marked with blue ellipses in the screen-shot above). Basically, this is

- the tire dimension (consisting of tire section width [mm] or [in], tire aspect ratio [%], and rim diameter [in]).
- the tire load and speed rating (in terms of standardized load index and speed symbol),
- the rim diameter [in]
- the nominal inflation pressure [bar]
- the total tire mass [kg]
- and the static tire deflection if it is loaded with the maximum permissible load [mm].

If a value is unknown, leave the field blank. *FTire/estim* will apply a qualified estimation.

Unfortunately, the tire community still uses a mixture of non-metric and metric units.

Unavoidably, this confusion is reflected in the menu.

To assist the user in finding the right units, all entry fields are labeled accordingly. Moreover, a simple unit conversion calculator is integrated in the menu (green ellipse). Just enter an arbitrary value in either of the entry fields, hit 'enter' as long as the entry field has focus, and read the value of the alternate unit.

Once you have entered all known values, hit the '**estimate tire data and save as ..**' button (magenta ellipse). This will

- open a file selection window (where you specify the path and name of the file to be generated), and, upon closing this window,
- invoke the estimation program.

Please be patient; computation might take a few seconds. This is because the tire data are not only generated, but also pre-processed. However, CPU-time needed to do so is not lost. Rather, this will save time when you launch a simulation with the generated file for the first time.

FTire/estim will automatically propose a file name, built by using the tire size. This name will look like 195_65R15_estim.tir. Specifying the file extension **.tir** will lead to generation of the MSC.ADAMS TeimOrbit file format; specifying **.ft** instead will generate cosin/io format.

The remaining yellow buttons are self-explaining:

- '**edit reference tire xxx.tir**' will load the reference data file in an editor, being Notepad by default (the name of the reference tire data file is automatically updated if it changes),

- 'choose reference tire ..' will open a file selection window to re-assign another data file to the reference tire,
- 'customize estimation formulae ..' will open another window with entry fields for user- defined estimation formulae (for more, see section 6.2),
- 'edit new data file' will load the generated data file into the editor. This button is greyed as long as it has not yet been generated in the running session,
- '?' will open *COSIN*'s on-line documentation,
- 'Explorer' will launch Windows Explorer, and
- 'quit' will stop the session and close the window.

As with all other components of *FTire/tools*, all values entered in any of the entry fields will be remembered from session to session. To completely reset *FTire/tools*, delete the file **fttools.ini** in the *ftire* subdirectory of your *COSIN* installation.

In the lower right corner of the window, you will find some external links, providing more information about tires. Any responsibility for the contents of these sites, or of sites linked to by these sites, is disclaimed.

6.2 Customizing Estimation Formulae

The customization window of the estimation formulae will allow you to define a new arithmetic expression for one or several of the estimated data items

- treadwidth
- lateral beltcurvatureradius
- flat tire: distance rim flange to ground
- rimmoment of inertia
- eigen-frequencyin-planerotatoric
- eigen-frequencyin-planetranslatoric
- eigen-frequency out-of-plane rotatoric
- eigen-frequencyin-planebending
- eigen-frequency out-of-plane bending
- wheelload on transversal cleat
- wheelload on longitudinal cleat
- wheelload of camberedtire
- wheel load of cambered tire on transversal cleat
- in-plane bending stiffness of un-inflated tire
- out-of-plane bending stiffness of inflated tire
- belt lateral bending stiffness of inflated tire
- belt twist stiffness
- belt torsionstiffness
- rimflangecontactstiffness

Such a formula defines the respective estimated value (x_{estim} , say) of the new data file, as function of that one of the reference file (x_{ref} , say), together with certain influence factors:

$$x_{estim} = f(x_{ref}, w, d, h, m, l, v, k, p)$$

You may enter function the $x_{estim} = f(x_{ref}, w, d, h, m, l, v, k, p)$ in terms of a very general arithmetic expression, basically following Matlab syntax. A complete documentation of this syntax is contained in the *cosin/io* documentation chapter.

x_{ref} and all influence factors made available by *FTire/estim* are to be referred to only by the following one-character parameter names:

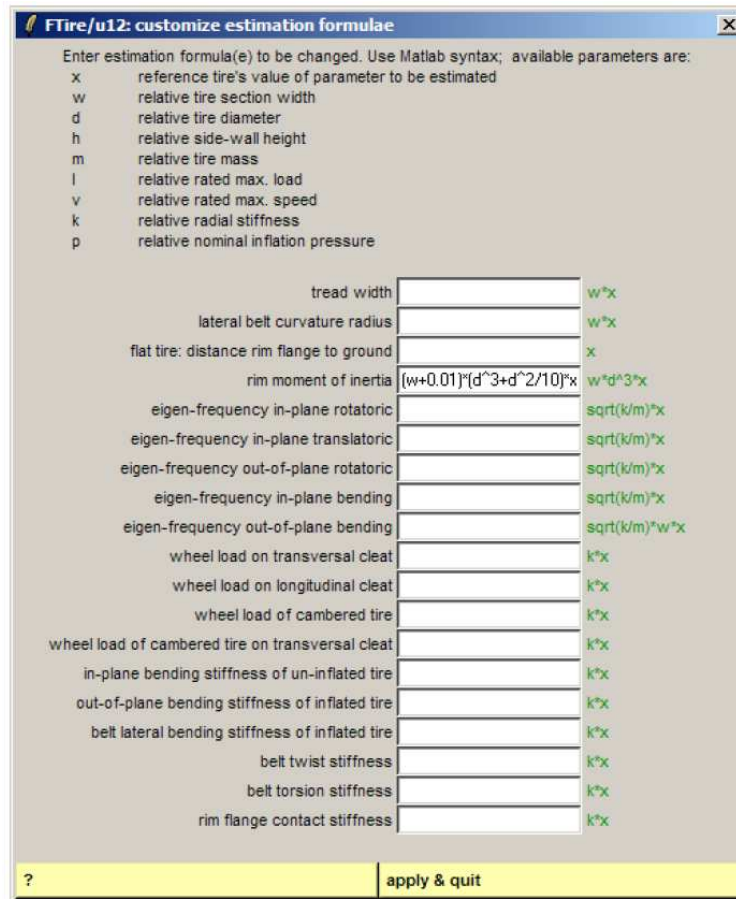
- x : reference tire's value of the data item to be estimated,
- w : relative sectionwidth,
- d : relative tire diameter of unloaded tire,
- h : relative height of side-wall (= tire radius - rim radius),
- m : relative total mass,
- l : relative rated maximum load (defined by LI index),
- v : relative rated maximum speed (defined by speed symbol),
- k : relative radial stiffness,
- p : relative nominal inflation pressure.

For all influence factors, 'relative' means: **value of estimated tire, divided by value of reference tire.**

As an example, the default value of the estimation formula for the rim's axial moment of inertia is $w \cdot d^3 \cdot x$, meaning: moment of inertia is proportional to rim width, and increasing with the diameter by the power of three:

$$j_{rim,estim} = w \cdot d^3 \cdot j_{rim,ref}$$

This default value is shown in the customization window as green string:



If you want to change the formula to a more detailed expression, like for example

$$j_{rim,estim} = (w + 0.01) \left(d^3 + \frac{d^2}{10} \right) j_{rim,ref}$$

you would have to enter the string $(w + 0.01) \cdot \left(d^3 + \frac{d^2}{10} \right) \cdot x$, like it is done in the screen-shot above.

Note that you only need to specify those formulae which differ from the default ones. Just leave blank all other fields, and click **apply & quit** to apply and save your changes, and to close the window.

7 More Tools

sorry, this documentation chapter is not yet available.