cosin scientific software

cosin scientific software AG

Hans-Stützle-Str. 20 81249 München GERMANY

info@cosin.eu www.cosin.eu

cosin/tools for tires

Documentation and User's Guide

Contents

1	cosir	n/tools for tires's Main Menu	1
2	cosir	n/tools for tires's Data Entry Menu (edit)	2
	2.1	Tire Size and Specification	3
	2.2	Geometry	4
	2.3	Carcass / Belt Mass & Stiffness	5
	2.4	Carcass / Belt Stiffn. (more)	8
	2.5	Carcass / Belt Damping	9
	2.6	Tread	10
	2.7	Friction	11
	2.8	Thermal & Wear	13
	29	Air Vibration	14
	2 10	Elexible / Visconlastic Rim	15
	2.10		16
	2.11		16
	2.12		10
	2.15		10
	2.14		20
	2.15		20
	2.16	Linked Files	21
	2.17	Animation & Sound	22
	2.18	Output	35
	2.19	Version Control	42
	2.20	Open in Text Editor	43
	2.21	Polish Data File	43
	2.22	Discard Pre-Processed Data	43

3	cosin/tools for tires's Data Analyzes Menu (analyze)	43
	3.1 Fingerprint	. 44
	3.2 General Properties	. 45
	3.3 Cross Section	. 45
	3.4 Mass correction data	. 45
	3.5 Local Belt Stiffness	. 46
	3.6 Pressure Dependencies	. 47
	3.7 Visualize Structural DOF's	. 47
	3.8 Vary Design Parameters	. 48
	3.9 Compare With	. 48
	3.10 Configurable Fingerprint	. 48
	3.11 Static Analysis	. 49
	3.12 Steady-State Analysis	. 53
	3.13 Interactive Analysis	. 55
	3.14 Linearization	. 57
	3.15 Modal Analysis	. 59
4	cosin/tools for tires's Data Processing Menu (process)	61
	4.1 Repeat Pre-Processing	. 61
	4.2 Optimize Numerical Settings	. 61
	4.3 Reformat	. 62
	4.4 Export To Pac2002 Model	. 63
5	cosin/tools for tires's Results Post-Processing Menu (post-process)	65
	5.1 Plot Results	. 65
	5.2 Replay Record File	. 66
	5.3 Replay Animation	. 66
	5.4 Show Wheel Envelope	. 66
6	cosin/tools for tires's Data Helpers Menu (helpers)	66
7	cosin/tools for tires's Menu-bar Functions	67

Preface

This documentation describes the tire data file editing and analysis tool **cosin/tools for tires**. For more material about **FTire**, and other tire simulation tools, please visit cosin.eu.

cosin/tools for tires is a convenient, GUI-based editor for FTire data files, especially helpful together with manual identification within FTire/fit. It allows easy access to all relevant FTire data, without detailed knowledge of the tire data file format.

This editor:

- groups together all important data into few small and manageable menus;
- renders unnecessary the use of an ASCII editor for data file changes;
- dramatically simplifies the finding and changing of parameter values;
- provides direct and rapid access to individual parameter descriptions in FTire's documentation chapter;
- allows easy changes in the selection choice of nominal modal/stiffness/steady-state data;
- indicates what parameters would actually be used with the current setting;
- provides simple access to several graphical data visualization tools;
- allows to select between SI and USC unit systems;
- allows to forcing renewal of pre-processing, or to disregard old pre-processed data;
- allows to easily 'undoing' latest or all changes during a session;
- provides short-cuts to several other FTire tools.

1 cosin/tools for tires's Main Menu

Figure 1 shows cosin/tools for tires's main menu. This menu will be loaded when a FTire data-file is opened from within all FTire applications.

cosin/f	tools for Tir Output	es 2018-4 Settings Hel	p		3 -		×
_default.	tir 🔍 🥒 1	i @ pp	rt? a	CO SC	sin ientific	: softv	vare
model last ac last m compa manuf brand size inflatio	type ccess odification at. date acturer on pressure	FTire 2018/10/11 1 2018/08/08 1 2099/12/31 n/a n/a 205/55 R 16 9 2.40 bar	1:45:43 9:06:01 1V 6.5J	accelerated exect tread pattern thermal model tread wear air vibration flex rim contact elements sidewall contact TPMS sensor statically balanced	ution with mass		Ь
edit	analyze	process	post-proce	ss helpers			С
tire	e size & spe	cification		imperfections			
geo	ometry			numerics			
				data meas. cond	itions		
	1000001000000	mass & stiffn.		operating condit	tions		
car	rcass / belt						
car	rcass / belt rcass / belt	stiffn. (more)		linked files			
car car car	rcass / belt rcass / belt rcass / belt	stiffn. (more) damping		linked files animation & sour	nd		
car car	rcass / belt rcass / belt rcass / belt	stiffn. (more) damping		linked files animation & sour output	nd		
car car car	rcass / belt rcass / belt rcass / belt	stiffn. (more) damping		linked files animation & sour output	nd		
car car car tre fric	rcass / beit rcass / beit rcass / beit vad ction	stiffn. (more) damping		linked files animation & sour output version control	nd		
car car car tre frid	rcass / belt rcass / belt rcass / belt ead ction ermal & wea	stiffn. (more) damping Ir		linked files animation & sour output version control	nd		
car car car tre fric the air	rcass / beit rcass / beit rcass / beit erad ction ermal & wea vibration	stiffn. (more) damping ur		linked files animation & sour output version control	nd		
car car car tre fric the air fie:	rcass / belt rcass / belt rcass / belt rad ction ermal & wea vibration xible / visco	stiffn. (more) damping tr pplastic rim		linked files animation & sour output version control open in text edil polish data file	nd		

Figure 1: cosin/tools for tires main menu

The cosin/tools for tires's main menu is divided into three regions. In the top region (section a in figure 1) the file name of the currently open tire data file is displayed. This section also includes four tools that can be used to analyze and view some of the tire properties:

- (loupe button), to show the effective tire cross section(see figure 4);
- / (edit button), to open the tire data file in an ASCII file editor;
- i (info button), to analyze and show the tire properties;
- (fingerprint button), left click the button to compute and show the finger print report. If the right mouse button is used the report will be competed, shown and saved to a user specified location.

- **pp** (**pre-process** button), pre-process tire data for non-RT speed modes. Selecting the button with the left mouse button will initiate the pre-processing calculation. Selecting the button with the right mouse button will force a repeat of the preprocessing. The color of the button indicates the quality of the pre-processing Grey= no pre-processed data is available, Green= OK, Red=Fail;
- Int (info button), pre-process tire data for RT (Real Time) speed modes (requires RT license). A real-time performance test will also be conducted, on a rgr road, to determine if the current machine is real-time capable. Selecting the button with the right mouse button will output the animation of the calculation. The color of the button indicates the quality of the pre-processing Grey= no pre-processed data is available, Green= OK, Red=Fail;

In section **b** a summary of the tire model properties are shown. The first entry defines the type of the tyre model, either FTire or HTire / MF 2002. The displayed information, and available tools, are dependent on the type of the opened tyre data file. If the opened tire data file is a **FTire** data file, the manufacturer, brand and tire size is shown (if available) on the left. The nominal tire inflation pressure, and 2nd inflation pressure (if defined), is also shown. On the right hand side the current speed-mode (SPM), as well as all activated model extensions are listed.

Section c allows the user to have direct access to several tools. The tools are grouped in the following tabs:

- 'edit', access to tire data entry menus (section 2);
- 'analyze', access to tire data analyzes tools (section 3);
- 'process', access to tire data processing tools (section 4);
- 'post-processing', access to tire results post-processing tools (section 5);
- 'helpers', access to the helpers menu (section 6).

2 cosin/tools for tires's Data Entry Menu (edit)

In the data entry menu (edit) all relevant parameters and model data is grouped into a few manageable menus. The data entry menu consists of the following sub-menus:

- Tire Size and Specification;
- Geometry;
- Carcass / Belt Mass & Stiffness;
- Carcass / Belt Stiffn. (more);
- Carcass / Belt Damping;
- Tread;
- Friction;
- Thermal & Wear;
- Air Vibration;

- Flexible / Viscoplastic Rim;
- TPMS;
- Imperfections;
- Numerics;
- Data Meas. Conditions;
- Operating Conditions;
- Animation & Sound;
- Output;
- Version Control;
- Open in Text Editor;
- Polish Data File;
- Discard Pre-Processed Data;

The menus allow easy access to all relevant model parameters by means of an entry field. By selecting the **?** (parameter information button) next to an entry field (see figure 2), cosin/tools for tires will display the FTire modelization and parameter specification documentation, together with links to the respective parameter description.

The buttons, in the bottom of all data entry menus (see figure 2), initiate the following:

- 'ok', will save all changes to the data file and close the data entry menu;
- 'cancel', will leave the menu, without saving the parameters to the data file;
- 'undo', will undo the most recent change, both in the menu and in the data file (if available);
- 'apply', will store all changed values in any of the entry fields in the data file without closing the data entry menu;

2.1 Tire Size and Specification

The tire size & specification menu groups all data entries that define the tire, and rim, size and key operating specifications. This information can often be found on the tyre side wall, by an alphanumeric tire code, and by product information that is published by the tire manufacturer. Entry fields of optional parameters, such as the tire polar moment of inertia, may be left empty or may be specified with the abbreviation n/a. For more information about the parameters, please visit the FTire modelization and parameter specification documentation.

C Tire size/specification: _default.tir (autosave)				>
ile Output Help				
tire size & specification				
manufacturer		?		
type		?		
tire construction ?	pneumat	tic tire C solid rubb	er C non-pneu	umatic tire (Tweel, ERW,)
filled with ?	Cair C	nitrogen C helium		,
tire section width 2	205	mm		
tire aspect ratio ?	55	*		
rim diameter ?	16	in		
load index ?	91			
speed symbol ?	v			
rim width ?	6.5	in		
rim contour symbol ?	J			
wheel offset (ET) ?	0	mm		
tire mass ?	8.1	kg		
tire moment of inertia about vertical axis ?	n/a	kgm^2		
tire moment of inertia about wheel spin axis ?	n/a	kgm^2		
rolling circumference ?	1916.91	mm		
nominal inflation pressure ?	2.4	bar		
second nominal inflation pressure ?	0	bar		
nominal tread depth ?	8	mm		
		ok	cancel	apply

Figure 2: cosin/tools for tires tire size and tire specification menu

2.2 Geometry

The geometry menu groups all parameters that can be used to specify the tire and rim geometrical shape. These parameters define the belt dimensions and effective belt shape, as well as the geometrical shape of the tread surface. Additional, and optional, parameters may also be defined the influence the calculation of the interior tire volume.

C Geometry data: _default.tir (autosave)					×
File Output Help					
basic geometry data					
tread width	? 178	mm			
belt width	? 178.72	mm			
lateral belt design curvature radius	? 1100	mm			
degree of contour smoothing polynomial	? n/a				
minimum tread shoulder height	? 65	%			
relative tread shoulder width	? 30	%			
total belt layers thickness	? n/a	mm			
inner liner thickness	? n/a	mm			
unloaded tire interior volume	? n/a	m^3			
volume gradient	? 0	%/mm			
detailed cross section geometry					
outer contour data file [mm] (void if n/a)	? 🚜				
belt/carcass cont. data file [mm] (void if n/a)	? 🙏				
number of cross-section modifiers	? 0	(sliders	to show in a	nimation wind	dow)
4.4.9.4.4.					
detailed rim geometry					
rim graphics (CAD) file ?		n/a			×0
			_		
		ok	cancel		apply

Figure 3: cosin/tools for tires geometry data menu

The optional detailed cross section geometry allows for the precise description of the tire's cross section geometry. If defined, they replace $r_{tread,lat}$, $w_{shoulder,rel}$ and $h_{shoulder,rel,min}$. Additional buttons are available to:

• ? (help button), to open the relevant help documentation;

- ••• (browse button), to select the spline data file;
- A (create button), to enter new contour table data in an ASCII file editor;
- 🖉 (edit button), to edit the contour table in an ASCII file editor;
- (loupe button), to show the effective tire cross section(see figure 4);
- 🔟 (delete button), to remove the spline data;

Selecting the \bigcirc (loupe button), will display a graphical representation of the model's cross section (figure 4), with the numerical carcass line shown in blue color, the tread surface shown in red color, and the contact element's position, direction, and length, also shown with red lines. The theoretical rim and tire main dimensions, as derived from the tire/rim size string, are indicated the light grey area. The maximum tire radius, and width, is also shown in the figure.



Figure 4: cosin/tools for tires cross-section geometry visualization

A name of an optional CAD data file in shl, obj, or stl format, containing the detailed rim geometry, may also be defined. Data will be automatically shifted, rotated, and scaled to exactly match the given rim size. This specification of the rim geometry is an alternative to the specification of the rim geometry in the animation settings, and is only needed when interfacing to cosin/prm. Additional buttons are available to:

- ? (help button), to open the relevant help documentation;
- X (clear button), to clear all the entry field;
- ••• (browse button), to select the rim CAD file;
- 🔍 (loupe button), to show the rim geometry;
- 🖉 (edit button), to edit the rim CAD file in an ASCII file editor;

2.3 Carcass / Belt Mass & Stiffness

Selecting the carcass / belt mass & stiffn. button, in the cosin/tools for tires main menu, will open a new window and allows entering parameters defining the primary carcass / belt mass and stiffness. The

mass and stiffness data for the nominal inflation pressure is shown in the first column. If a secondary pressure is defined, the pressure dependent stiffness data will be shown in a second column.

In the top section of the carcass / belt mass & stiffn. menu the tire radial stiffness is defined. Additional mass and stiffness parameters, and their respective specification alternatives, are listed in the bottom section of the menu. The parameters are grouped according to the parameter type, and can be accessed by selecting the tabs in the sub menu(see figure 5, 7 and 8). The data in this section is also arranged in columns, corresponding to the nominal and second(if available) inflation pressure. In some special cases a yellow radio-button, with a corresponding nominal parameter value, will be available in a parameter row. This nominal value has been determined on basis of a special measurement and is not used otherwise. Selecting the yellow radio-button will select the parameter for usage. Note that nominal values are only displayed, but cannot be changed in the menu. This is because nominal values are determined from measurements, and by this are not subject to user changes. Clearly, only those nominal value selection buttons will be displayed for which values are available in the data file.

Figure 5 shows the direct mass and stiffness data on the left, and the modal data on the right-hand side. The tire's structural stiffness can be defined by specifying static tire stiffness data together with the free vibrating mass (direct), or by specifying the tire modal, handling and or static parameters. See FTire modelization and parameter specification documentation for more details.



Figure 5: cosin/tools for tires carcass/belt mass & stiffn. data menu; Left: direct; Right: modal

The carcass / belt mass & stiffn. menu does not only allow entering parameter values for belt and carcass mass and stiffness, but also the selection which of these parameters are actually to be used during preprocessing. This is done by selecting on of the two radio-buttons associated with the respective parameter (figure 5). Selecting the red radio-button will exclude the parameter from pre-processing, while selecting the blue radio-button will include the parameter.

Note that the selection/deselection of parameters might have a wanted side-effect. For several combi-

nations of parameters, $\cos in/tools$ for tires knows dependencies which require deselection of one, or more, parameter/s, if another one is selected. To confirm that the system is not over defined, and to see which parameter set is used during preprocessing, the \bigcirc (loupe button), in the bottom left comer of the carcass / belt mass & stiffn. menu, may be used. In a separate information window (figure 6), $\cos in/tools$ for tires will show exactly what parameters are specified and used, and what parameters are disregarded.

C u	used data				×
File	Output	Help			
in-j	plane, pr	essure 1			
C	1) rolling	circumferer	ice		
G	2) stat. Fz	at first tire (deflection		
0	3) stat. Fz	at second t	ire deflecti	on	
(4) long. st	iffness			
C	5) dampin	g ratio of ro	tatoric in-p	lane mode	
(6) dampin	g ratio of tra	inslatoric in	-plane mode	
out	t-of-plane	e, pressure 1	I.		
C	1) lat. stiff	ness			
G	2) dampin	g ratio of ro	tatoric out-	of-plane mod	е

Figure 6: cosin/tools for tires used data window

Figure 7 shows the carcass/belt mass & stiffn 'static horizontal' sub menu, left; and the 'static vertical' sub menu on the right-hand side. In addition to the parameter entry fields, additional entry fields are available to define the tire radial deflection that was applied during the measurements of the subsequent stiffness and FZ decrease values.

adial stiff	ness data		at 2.4 b	ar inf	lation pressu	ire		radial stiffness data	at 2.4	bar ir	nflatio	on pressu	re
15	t wheel load	I / deflection on flat road	? 3015.5	N	at 18.2	mm	í.	1st wheel load / deflection on flat road ?	3015.5	N	at	18.2	mm
2n	d wheel load	I / deflection on flat road	? 6 031.1	N	at 32.4	mm	i -	2nd wheel load / deflection on flat road ?	6031.1	N	at	32.4	mm
nore mass	ቂ stiffness	s data and respective sp	ecification al	terna	tives			more mass & stiffness data and respective specif	cation	alterr	native	95	
direct	modal	static horizontal	static vertic	al	handling	oth	er	direct modal static horizontal sta	ic vert	ical	h	andling	othe
sta	atics data (I	horizontal)	at 2.4	bar	inflation pres	sure		statics data (vertical)	at 2	.4 ba	r infla	ation pres	sure
		tire longitudinal stiffness	s [N/mm] ? C	•	228.755	C	23	Fz decrease on transversal cleat	[%] ?	•		10	с.
		tire lateral stiffness	s [N/mm] ? C	•	111.279	C	11	Fz decrease on longitudinal cleat	[%] ?	•	0	10	
		tire torsional stiffness [Nm/deg] ? 여	C	41.3306			Fz decrease with camber	[%] ?	•		10	
								Fz decrease on transv. cleat with camber	[%] ?	•	2	20	
	y	wheel load at longitudinal	stiffness ?	5026.	69 N								
		wheel load at lateral	stiffness ?	5018.	05 N			radial deflection at Fz decrease measurem	ent	32.4	ſ	nm	
		wheel load at torsional	stiffness ?	5026.	69 N								

Figure 7: cosin/tools for tires carcass/belt mass & stiffn.; Left: static horizontal; Right: static vertical

Figure 8 shows the carcass/belt mass & stiffn static 'handling' sub menu, left; and the 'other' sub menu on the right-hand side. In addition to the parameter entry fields, additional entry fields are available to define the tire radial deflection that was applied during the measurements of the subsequent stiffness values.

adial stiffness data		at 2.4	bar	inflat	ion pressur	re	radial stiff	ness data		at 2.4 I	oar infl	lation pressu	re
1st wheel load	/ deflection on flat road	? 3015.	5	N at	t 18.2	mm	1s	t wheel load	/ deflection on flat roa	ad ? 3015.5	N	at 18.2	mm
2nd wheel load	/ deflection on flat road	? 6031.	1	N at	32.4	mm	2n	d wheel load	/ deflection on flat roa	ad ? 6031.1	N	at 32.4	mm
ore mass & stiffness	data and respective spe	ecification	alte	rnativ	ves		more mass	ት stiffness	data and respective :	specification a	ilterna	tives	
direct modal	static horizontal	static ver	ical	1	handling	other	direct	modal	static horizontal	static verti	cal	handling	other
handling data	slip stiffness cornering stiffness [J camber stiffness [J pneumatic tr radial deflection at slip s n at cornering / camber s	at 2 (KN/%) ? (N/deg) ? ail [mm] ? tiffness ?	2.4 b (* (* (* 18	ar inf C C C .1614 .1614	lation press 0.697891 0.960503 0.0638405 16.2782 mm mm	sure	me	ore pressure	e dependent nonline initial radial stiffne	arities at 2. sss [N/mm] ?	4 bar i	nflation pres	sure

Figure 8: cosin/tools for tires carcass/belt mass & stiffn. data menu; Left: handling; Right: other

2.4 Carcass / Belt Stiffn. (more)

The additional belt stiffness data menu is shown in figure 9. The menu consist of four sections:

- belt kinematics & special structural stiffness data
 - items in this group, among others, define the progressivity, of various stiffness parameters, and the assumed coupling of various parameters.
- side wall contact model
 - radio-buttons to activate/deactivate the sidewall contact model. If the sidewall contact model is activated, tire contact elements will be activated on the tyre sidewall, allowing the sidewall to make contact with the road. If this model is activated, it is recommended to increase the number of contact elements, to ensure the model fidelity.
- stiffness data for misuse conditions
 - items in this group, among others, define the progressive radial stiffness property of the tire when the tire inner liner near a belt edge touches the inner side of the bead, and thus comes into indirect contact with the rim flange.
- tire/rim bead friction data
 - optional items to define the sticking and sliding friction torque between the tire and the rim

C Secondary carcass / belt stiffness data: _default	tir (auto:	osave) X
File Output Help		
belt kinematics & special structural stiffness dat	a	
longitudinal stiffness progressivity ?	- 10	%
lateral stiffness progressivity ?	-10	*
max. radial progressivity ?	120	%
belt torsion-to-lateral-displacement coupling ?	0	deg/mm
belt torsion-to-oop-bending coupling ?	1	
belt extension due to speed at rated speed ?	1	%
relative longitudinal belt membrane tension ?	80	%
long. belt membrane tension degressivity ?	0	%
radial stiffn. to lateral belt bend. coupling ?	0.5	
relative belt edge width ?	0	%
relative belt edge lateral bending stiffness ?	100	%
lateral belt bending longitudinal coupling ?	0.5	
lateral belt bending progressivity ?	0	×
side wall contact model		
C activate (* deactivate		
stiffness data for misuse conditions		
rim flange contact stiffness ?	1000	N/mm
rim flange contact stiffness progressivity ?	600	%
rim-to-flat-tire distance ?	10	mm
rim-to-road contact stiffness ?	5.0e08	N/mm
rim-to-road contact friction coefficient ?	0.3	
side-wall stretching stiffness factor ?	20	
tire/rim bead friction data	- (-	Ne
sticking torque ?	n/a	Nm
soung torque r	II/d	ren
		ok cancel apply
		apply

Figure 9: cosin/tools for tires additional belt stiffness data menu

2.5 Carcass / Belt Damping

The damping data menu (shown in figure 10) groups the damping parameters into three sections:

- damping data
 - items in this group, among others, define the respective modal damping values, belt torsional damping and lateral belt damping parameters;
- dynamic stiffening data
 - defining the dynamic tire stiffening, at higher rolling speeds, in radial, tangential (longitudinal), and lateral direction;
- hysteresis data
 - describes the structural friction properties which cause the hysteresis loops in radial, tangential (longitudinal), and lateral stiffness characteristics;

Damping data: _defaultir (autosave) le Output Help damping data at 2.4 bar inflation pressu D1 in-plane rot. ? 0.00901 D2 in-plane trans. ? 0.05137 D4 out-or-plane rot. ? 0.00945 bett torsion/twist damping ? 5 odynamic stiffening data	e 89 - 58 - 89 - % 5
damping data t 2.4 bar inflation pressu D1 in-plane rot. ? 0.0091 D2 in-plane transl. ? 0.0013 D4 out-of-plane rot. ? 0.00694 bett tarstan transl. ? 0 out-of-plane rot. ? 0 outplane transl. ? 0 outplanet transl. ? 0 out	e 55 - 59 - 59 - % 5
damping data at 1.4 bar inflation pressu D1 in-plane rot. ? 0.09016 D2 in-plane trans. ? 0.05137 D4 out-of-plane trans. ? 0.06533 bet torsion fiviat damping ? 5 bet lateral bending damping ? 0 dynamic stiffening data	e 89 - 58 - 89 - % 5
D in-plane rot. ? 0.0000 D2 in-plane transi. ? 0.06933 D4 out-of-plane rot. ? 0.06943 bet vort-of-plane rot. ? 0.06943 bet lateral bending damping ? 0 dynamic stiffening data	269 - 588 - 699 - % %
D2 in-plane transi. ? 0.05135 D4 out-of-plane rot. ? 0.06945 betit torsion/twist damping ? 5 betit lateral bending damping ? 0 dynamic stiffening data	58 - 89 - % 5
D4 out-of-plane rot. ? 0.06945 bett torsion/twist damping ? 5 bett lateral bending damping ? 0 dynamic stiffening data	89 - % S
belt torsion/twist damping ? 5 belt lateral bending damping ? 0 dynamic stiffening data	% S
belt lateral bending damping ? 0 dynamic stiffening data	5
dynamic stiffening data	
dynamic stiffening data	
radial dynamic stiffening ? 20.074	9 %
tangential (long.) dynamic stiffening ? 5.129	N 10
lateral dynamic stiffening ? 0	%
time constant dynamic stiffening ? 0.01540	08 s
hysteresis data	
1. term radial stiffening by hysteresis ? 0	*
1. term radial hysteresis width ? 0	N
Z. term radial stiffening by hysteresis ? 0	*
Z. term radial hysteresis width ? 0	N
3. term radial stiffening by hysteresis ? 0	8
3. term radial hysteresis width ? 0	N
 term radial stiffening by hysteresis ? 0 	*
4. term radial hysteresis width ? 0	N
5. term radial stiffening by hysteresis ? 0	%
5. term radial hysteresis width ? 0	N
tangential (long.) stiffening by hysteresis? 0	%
tangential (long.) hysteresis width ? 0	N
lateral stiffening by hysteresis ? 0	*
lateral hysteresis width ? 0	N

Figure 10: cosin/tools for tires damping data menu

2.6 Tread

The tread data menu (shown in figure 11) groups all parameters to describe the tire tread, into two sections:

- tread stiffness data
 - items in this group, among others, define the tread depth, stiffness and shape factors;
- tread pattern data
 - radio-buttons to activate/deactivate the tread pattern. If activated FTire will set the contact element height according to the specified tread pattern.
 - tread pattern image file (supported image file formats are png, gif, tiff, bmp) or geometry defining string, with the following buttons:
 - * ? (help button), to open the relevant help documentation;
 - * X (clear button), to clear all the entry field;
 - * *** (browse button), to select the tread pattern image file;
 - * 🔍 (loupe button), to display the tread pattern image file;
 - i (info button), compute, and show, the net-to-gross tire contact distribution; Left click: show longitudinal distribution; Right click: show lateral distribution;

Tread data: default tir (autocave)					
ne Output Help					
tread stiffness data					
tread depth ?	8	mm			
tread base height ?	3	mm			
stiffness tread rubber ?	70	ShoreA	к. — — — — — — — — — — — — — — — — — — —		
stiffness progressivity tread rubber ?	600	%			
net-to-gross percentage ?	65	%			
tread pattern shape factor (tangential) ?	1				
tread pattern shape factor (longitudinal) ?	0				
tread pattern shape factor (tors+bend) ?	n/a				
lateral/longitudinal tread stiffness ratio ?	1				
sidewall/tread stiffness ratio ?	0.1				
damping tread rubber ?	0.0002	s			
tread gluing force percentage ?	0	%			
contact elements with mass					
C activate 💽 deactivate					
tread pattern data					
C activate deactivate					
tread pattern image file / geom. def. string ?		grooves	4 10 20 40 60	80	×Q. i
xmin tread pattern ?	n/a				
xmax tread pattern ?	n/a				
vmin tread pattern ?	n/a				
ymax tread pattern ?	n/a				
standard variation tread pattern spacing ?	n/a	×			
The function of call parcent spacing 1		~			

Figure 11: cosin/tools for tires tread data menu

2.7 Friction

In the friction data menu (figure 12), the group of variables that describe the dry friction characteristics of the friction couple tread rubber / road surface under normal road conditions is shown. The friction coefficient is a function of the three independent variables **sliding velocity**, **ground pressure**, and **tread rubber temperature**.

In the top section of the friction menu, the sliding velocity and ground pressure influence on friction is shown in a 2-Dimensional table. The friction coefficients can be changed individually, by entering a respective numerical value, or alternatively, complete columns, or rows, or even all values at the same time, can be increased or decreased simultaneously. This is done by clicking a respective '<' or '>' button for a single **column**, or **row**, or the '<<<' or '>>>' buttons for **all** values .

Alternatively, a group of coefficients can be increased or decreased by turning the **mouse wheel** up or down, as long as the mouse points to one of the respective '<' or '>' buttons. In this mode, it doesn't make a difference whether the mouse points to the '<' or to the '>' button. Only the mouse wheel turning direction defines the increase or decrease of values by a constant factor. With the button 'reset all to 1.0', all friction coefficients can be reset to the default value '1'.

C Friction data: _default.tir (autosave)											
File Output	Help										
sliding veloc	ity and grou	nd press	ure influenc	e on frictio	n ?						
			ground pres	round pressure [bar]							
sliding v	elocity [m/s]	low	0	medium	0.472283	high	0.944566				
a stiction	0		1.33146		1.17169		1.01193	•	•		
@ max. frict	0.0639334		1.95437		1.71986		1.48535	•	->		
a sliding	0.127867		1.45304		1.27869		1.10433	<	>		
blocking blocking	44.6069		0.648974		0.571102		0.49323	<	>		
			< >		< >		< >				
				<<<		>>>					
				re	eset all to 1.	0					
temperature	e influence o	n friction									
ه	polynomial	C look-u	ptable C	WLF trafo							
frict	tion correctio	on factor a	at -20 degC '	? n/a							
fric	tion correcti	ion factor	at 20 degC '	? n/a	•						
1	friction corre	ction fact	or at Tmax '	? n/a							
max	. temp. used i	in temp/fr	riction dep. '	? 80	degC						
mu(p,)	mu(v,)	mu(T	,)		ok	cancel		ap	oply		

Figure 12: cosin/tools for tires friction data menu

In the bottom section of the friction menu, the temperature influence on friction can be specified. For this a set of friction correction factors need to be defined. For a more detailed way to specify the temperature influence, on the friction behavior, a optional look-up table or WLF transform can be defined (Thermal & Wear).

The buttons in the bottom right corner of the friction window, can be used to plot the friction dependencies on the three independent variables:

- 'mu(p,..)', to plot the friction coefficients vs. ground pressure friction behavior (shown on the left-hand side of figure 13);
- 'mu(v,..)', to plot the friction coefficients vs. sliding velocity friction behavior (shown on the right-hand side of figure 13);



• 'mu(T,..)', to plot the friction coefficients vs. surface temperature friction behavior.

Figure 13: cosin/tools for tires friction data visualization

2.8 Thermal & Wear

The thermal and wear menu (shown in figure 14) displays all parameters that are used in the tire thermal and wear models. The menu is divided into three sections:

- thermal model
 - radio-buttons to activate/deactivate the thermal model;
 - items in this group define the parameters that used in the heat generation and heat transfer model;
- temperature influence on friction
 - items in this group define the temperature influence on friction. Radio-buttons to specify the optional data using a:
 - * polynomial, polynomial that defines the temperature influence on friction.
 - · entry fields to define polynomial friction corrections factors;
 - * look-up table, table that defines the fiction factor change vs. temperature. The following buttons are available:
 - · ? (help button), to open the relevant help documentation;
 - · A (create button), to create the table in an ASCII file editor;
 - (edit button), to edit the table in an ASCII file editor;
 - · ••• (browse button), to select the spline data file;
 - 'smooth' (check-box), if selected a smooth spline interpolation will be used, deselect to use the piecewise linear interpolation method for the table data;
 - · • (loupe button), to plot the specified table data;
 - \cdot $\boxed{\blacksquare}$ (delete button), to remove the table data;
 - * WLF trafo, Williams-Landel-Ferry equation that defines the temperature influence on friction.
 - · entry field to define the tread rubber glass temperature;

• temperature influence on stiffness

- items in this group define the temperature influence on friction, structural stiffness and the tread stiffness. This optional spline or table data can be specified and analysed with the following buttons:
 - * ? (help button), to open the relevant help documentation;
 - * **A** (create button), to create the table in an ASCII file editor;
 - * 🖉 (edit button), to edit the table in an ASCII file editor;
 - * ••• (browse button), to select the spline data file;

- * 'smooth' (check-box), if selected a smooth spline interpolation will be used for the table data, deselect to use the piecewise linear interpolation method;
- * (loupe button), to plot the specified table data;
- * 🗐 (delete button), to remove the table data;
- tread wear model
 - radio-buttons to activate/activate averaged/only compute/deactivate the tread wear model;
 - lists all parameters that define the tread wear model.

C Thermal and tread wear data: _default.tir (autos;	ave)		×
file Output Help			
thermal model			
C activate G deactivate			
heating time constant of tire structure ?	10	5	
heating time constant of tread ?	0.01	- s	
tire heating at reference slip and 25% ymax ?	40	degC	
tread heating at reference slip and 25% vmax ?	60	degC	
tread heating at reference slip and 50% vmax ?	60	degC	
tread heating at reference slip and 100% vmax ?	60	degC	
tread heating reference slip ?	10	%	
% of friction power to heat tread ?	100	%	
temperature influence on friction			
polynomial C look-up table C WLF	trafo		
tread rubber glass temperature ?	n/a	degC	
friction correction factor at -20 degC ?	n/a		
friction correction factor at 20 degC ?	n/a		
friction correction factor at Tmax ?	n/a		
max. temp. used in temp/friction dep. ?	80	degC	
temperature influence on stiffness			
factor structural stiffn, change vs. temp. ?		nooth 🔾 🔟	
factor trad stiffs, change up tamp 2.4	·	nooth	
Tactor tread stiffit change vs. temp. : 🖉	\$•••• J v ⊃i	lootii	
tread wear model			
C activate C activate, averaged C	only com	pute input 📀 deactivate	
wear rate coefficient ?	0		
wear rate exponent ?	1		
default fill		ok cancel	apply

Figure 14: cosin/tools for tires thermal and tread wear data menu

Two additional buttons are available in the bottom right corner of the window:

- 'default', to reset all data in the current menu to the default values (if available)
- 'fill', to complete all missing/empty data entry fields, in the current menu, with the default values (if available)

2.9 Air Vibration

The air vibration menu (shown in figure 15) displays all parameters that are used in the air vibration model. The menu is divided into two sections:

- air vibration activation
 - radio-buttons to activate the standard model/activate the detailed model/deactivate the air vibration model;

• filling gas

- radio-buttons to select the tire filling gas. A selection between air, nitrogen or helium is possible.

A additional button is available in the bottom right corner of the window:

• 'default', to reset all data in the current menu to the default values (if available)

C Air vibration model data: _default.tir (autosave)			×
File Output Help			
air vibration model activation C activate standard model C activate det filling gas	ailed model (
€ air ⊂ nitrogen ⊂ helium			
default	ok	cancel	apply

Figure 15: cosin/tools for tires air vibration data menu

2.10 Flexible / Viscoplastic Rim

The flexible or viscoplastic rim menu (shown in figure 16) displays all parameters that are used in the flexible rim models. The menu is divided into three sections:

- flexible viscoplastic rim model activation
 - radio-buttons to activate the internal model/activate the user-defined model/deactivate the rim model;
- model data file
 - entry field to specify the optional rim data file. The following buttons are available:
 - * ? (help button), to open the relevant help documentation;
 - * X (clear button), to clear all the entry field;
 - * ••• (browse button), to select the rim data file;
 - * 🔍 (loupe button), to display the rim data file;
 - * 🖉 (edit button), to edit the rim data file;
- model data

Two additional buttons are available in the bottom right corner of the window:

- 'default', to reset all data in the current menu to the default values (if available)
- 'fill', to complete all missing/empty data entry fields, in the current menu, with the default values (if available)

C Flexible / viscoplastic rim model: _default.tir (au	tosave)				×			
File Output Help								
flexible / viscoplastic rim model activation								
C activate internal model C activate	user-defir	ed model	deactive	ate				
model data file								
rim flexibility data file ?		n/a			×🔍 🥒			
model data								
only used with internal model,	and if no	nodel data	file is specif	fied:				
specific lateral rim stiffness ?	100	N/mm^2						
specific radial rim stiffness ?	100	N/mm^2						
angle where force influence is reduced to 50 $\%$?	10	deg						
number of rim spokes ?	5	-						
rim stiffness variation caused by spokes ?	50	%						
max. elastic lateral rim node displacement ?	5	mm						
max. elastic radial rim node displacement ?	5	mm						
radial stiffness percentage at inner rim side ?	50	%						
in-plane torsional rim stiffness ?	n/a	Nm/deg						
angular position of first rim spoke ?	0	deg						
default fill		ok	cancel		apply			

Figure 16: cosin/tools for tires thermal and tread wear data menu

2.11 TPMS

The tire pressure monitoring system (TPMS) menu (shown in figure 17) displays all parameters that are used to define a TPMS sensor. The menu is divided into two sections:

- TPMS sensor model activation
 - radio-buttons to activate/deactivate the sensor;
- TPMS sensor position and mass
 - parameters defining the position and mass of the sensor;





2.12 Imperfections

The imperfections menu (shown in figure 18) displays all parameters that are used to simulate imbalances in the tire by inhomogeneous mass and stiffness distribution and geometric imperfections. The menu is divided into three sections:

- imbalance data
 - defines the optional static and dynamic mass imbalance data

- defines a optional one dimensional mass variation table or spline.
 - * ? (help button), to open the relevant help documentation;
 - * **A** (create button), to create the table in an ASCII file editor;
 - * 🖉 (edit button), to edit the table in an ASCII file editor;
 - * ••• (browse button), to select the spline data file;
 - * 'smooth' (check-box), if selected a smooth spline interpolation will be used for the table data, deselect to use the piecewise linear interpolation method;
 - * (loupe button), to plot the specified table data;
 - * $\overline{\blacksquare}$ (delete button), to remove the table data;

non-uniformity data

- defines the optional radial and tangential stiffness non-uniformity
- defines a optional one dimensional radial and tangential stiffness non-uniformity table or spline.
 - * ? (help button), to open the relevant help documentation;
 - * **A** (create button), to create the table in an ASCII file editor;
 - * 🖉 (edit button), to edit the table in an ASCII file editor;
 - * ••• (browse button), to select the spline data file;
 - * 'smooth' (check-box), if selected a smooth spline interpolation will be used for the table data, deselect to use the piecewise linear interpolation method;
 - * (loupe button), to plot the specified table data;
 - * 🗐 (delete button), to remove the table data;
- geometry imperfections
 - items in this group, among others, define optional geometry imperfections such as conicity and ply-steer
 - optional one and two dimensional radius and tread gauge variations,
 - * ? (help button), to open the relevant help documentation;
 - * **A** (create button), to create the table in an ASCII file editor;
 - * 🖉 (edit button), to edit the table in an ASCII file editor;
 - * ••• (browse button), to select the spline data file;
 - * 'smooth' (check-box), if selected a smooth spline interpolation will be used for the table data, deselect to use the piecewise linear interpolation method;
 - * (loupe button), to plot the specified table data;
 - * $\overline{\blacksquare}$ (delete button), to remove the table data;

A additional button is available in the bottom right corner of the window:

• 'default', to reset all data in the current menu to the default values (if available)

C Importaction data, datault tir (autocaus)				
imperiection data: _deradit.tir (autosave)				
lie Output Help				
imbalance data				
necessary balance weight for static balance ?)	g		
angular position of static balance weight ?)	deg		
necessary balance weights for dyn. balance ?)	g		
ang. position of outer dyn. balance weight ?)	deg		
1D mass variation ? 🙏 …	🔽 sm	ooth		
balance statically ? 🦵				
non-uniformity data				
radial non-uniformity ? 0)	%		
angular position of maximum radial stiffness ? 0)	deg		
tangential non-uniformity ? 0)	%		
angular position of maximum tang. stiffness ?)	deg		
1D radial non-uniformity ? 🦧 🚥	⊽ sm	ooth		
1D tangential non-uniformity ? 🖧 🚥	⊽ sm	ooth		
geometry imperfections				
belt conicity ?)	deg		
ply-steer percentage ? 0)	%		
run-out amplitude ?)	mm		
angular position of maximum run-out ?)	deg		
1D radius variation ? 🧟	⊽ sm	poth		
1D tread gauge variation ? A	v sm	ooth		
2D radius variation ? A				
2D tread gauge variation ? 2				
To creat Page random 1 Me				

Figure 18: cosin/tools for tires imperfection data menu

2.13 Numerics

This dataset controls the numerical properties of FTire (shown in figure 19 and 20). In the top section the **FTire** run-time speed mode can be set by selecting the corresponding radio-button. An additional license key is required for the accelerated run-time mode level 3 and 4, as well as for all real-time run-time mode levels.

The pre-processing sub menu (shown on the left-hand side of figure 19) menu displays the numerical properties the control the pre-processing.

The run-time sub menu (shown on the right-hand side of figure 19) menu displays all run-time numerical settings. The settings in this sub-menu are dependent on the selected run-time mode. The run-time mode should thus be defined first before changing any of the run-time sub menu entries. The sub menu is divided into three sections:

- mesh size
 - items in this section define the FTire mesh resolution
- integrator
 - items in this section control the numerical integrator, such as the integration step size and parameters that control the implicit integration scheme;
- contact processor

- items in this group control the tire-road contact processor.

Two additional buttons are available in the bottom right corner of the numerics window:

- 'default', to reset all data in the current menu to the default values (if available)
- 'RTF?', to determine the real-time factor (RTF) with the current parameter values and numerical settings

e Output Help				File Output Help					
run-time mode (* re	quires FTire/acc or FTire/HiL li	cense)		run-time mode (* re	quires FTire/	acc or FTire/HiL l	icense)		
	standard 🕫				standard 📀				
accelera	ated, level C 1 C 2 C 3*	C 4*		accelera	ated, level 🧲	1 C 2 C 3*	C 4*		
real-	time, level (~ 1,2* (~ 3,4* (~	5*		real-t	time, level C	1,2* 🗅 3,4* ଠ	5*		
pre-processing	run time interfacing			pre-processing	run <mark>tim</mark> e	interfacing			
pre-processing n	umerics			mesh size					
tolerate	ed residuum in pre-processing ?	1.0e-8			4	belt segments ?	80	•	
	max. # iteration cycles ?	1		# bel	t bending degr	ees of freedom ?	7	•	
s	tep size for static calculation ?	0.003	5	# conta	ct elements pe	r belt segment ?	40	•	
BDF par	rameter for static calculation ?	4				# tread strips ?	20	•	
mass reduction	n factor for static calculation ?	0.01							
inertia red	. factor for static calculation ?	0.01		integrator			0.0000		
3	step size Jacobian estimation ?	0.001			Int	ernal time step ?	0.0002	s	
tolerated r	esiduum in statics calculation ?	1.0e-8			PDE param	ater structure 2	0.5	ueg	
ma:	x. iteration number in statics ?	1.0e4			BDE paramete	ar air vibration 2	0.5		
					Jacobian unda	te cycle length ?	1		
					Jacobian u	ndate fraction ?	1		
						pour morner r			
				contact processo	or 🛛				
					contact pr	ocessor bound ?	35	%	
				co	ntact process	or cycle length ?	1	-	
				high	precision road	I tangent plane ?	Г		
					_			-	
default RTF	? ok	can	cel apply	default RTF	?	ok	can	cel	apply

Figure 19: cosin/tools for tires numerical settings menu; Left: pre-processing, Right: run time

The interfacing sub menu is shown in figure 20. The settings control the interfacing numerics, that are used in the interface with 3rd-party environments, and can be used to generate extra output files for cosin/prm or CFD co-simulations.

C Numerics data: _default.tir (autosave)
File Output Help
run-time mode (* requires FTire/acc or FTire/HiL license) standard G accelerated, jevel C 1 C 2 C 3* C 4* real-time, jevel C 1.2* C 3.4* C 5*
pre-processing run time interfacing
interfacing numerics statics accuracy ? ⓒ std ⓒ better ⓒ best
tread surface output for prm or CFD cosim. ?
surface output longitudinal resolution ? n/a mm surface output lateral resolution ? n/a mm
default RTF? ok cancel apply

Figure 20: cosin/tools for tires numerical settings sub menu: interfacing

2.14 Data Meas. Conditions

The data meas. conditions menu (shown in figure 21) lists all parameters that define the measurement conditions of the parameterization tests.

C Measurement conditions: _default.tir (autosave))	X
File Output Help		
measurement conditions		
nominal inflation pressure 2	2.4	har
2nd inflation pressure 2	0	bar
tread depth @ vertical stiffness ?	8	mm
tread depth @ horizontal stiffness ?	8	
manurement cleat width 2	50	
measurement cleat have adea width 2	0	
rim avial moment of inertia 2	0 155994	kom^2
rim axial moment of inertia ?	0.155000	kgili Z
rim radiachioment of mercia y d	0.0779431	
tire side y o	 not spec 	med C left C right C symmetric
radial deflection at horizontal stiffness measurem	nents	
@ slip stiffness ?	18.1614	mm
@ cornering/camber stiffness ?	18.1614	mm
wheel load at horizontal stiffness measurements		
@ longitudinal stiffness ?	5026.69	N
@ longitudinal stiffness, 2nd infl. press. ?	5026.69	N
@ lateral stiffness ?	5018.05	N
a lateral stiffness, 2nd infl. press. ?	5018.05	N
@ torsional stiffness ?	5026.69	N
a torsional stiffness, 2nd infl. press. ?	5026.69	N
@ cornering/camber stiffness, 2nd infl, press, ?	1	
C		
2		

Figure 21: cosin/tools for tires measurement conditions menu

The menu is divided into three sections:

- measurement conditions
 - items in this section define, among others, the used inflation pressures, tread depth, cleat dimensions and rim moment of inertia;
- radial deflection at horizontal stiffness measurements
 - items in this section define, among others, the radial tire deflection during the longitudinal, slip and cornering/camber stiffness measurements;
- · wheel load at horizontal stiffness measurements
 - defines the wheel load during horizontal stiffness measurements.

2.15 Operating Conditions

The operating conditions menu (shown in figure 22) lists all parameters that define the actual operating conditions, or initial conditions, of the FTire model. Certain tire data can be controlled during a simulation, without re-running the pre-processing step. These parameters are called operating condition parameters. The available operating conditions are:

- actual inflation pressure;
- actual tread depth;

- tread and filling gas temperature;
- road and ambient temperature;
- gravity.

C Operating conditions: _default.tir (autosave)					
File Output Help					
operating conditions					
actual inflation pressure ?	n/a	bar			
actual tread depth at belt zenith ?	n/a	mm			
actual/initial filling gas temperature ?	n/a	degC			
actual/initial mean tread surface temperature ?	n/a	degC			
(tire temperature values serve as initial condition	is if ther	mal model i	is active)		
ambient temperature ?	n/a	degC			
road surface temperature ?	n/a	degC			
gravity ? 6	earth	C moon	C mars	C zero	
				_	
default		ok	cancel		apply

Figure 22: cosin/tools for tires operating conditions menu

2.16 Linked Files

The linked files menu (shown in figure 23) lists all files, and optional library path, that are linked to this tire data file. The following files are listed in this section:

- tread patter image / geometry definition string;
- rim data file;
- sidewall texture image;
- rim graphics (CAD) file;
- car-body graphics (CAD) file;
- sound file;
- user library path.

The following buttons are available:

- ? (help button), to open the relevant help documentation;
- X (clear button), to clear all the entry field;
- ••• (browse button), to select a file;
- (loupe button), to display the contents of the file;
- 🖉 (edit button), to edit the file.

le Output Help		
linked files		
tread pattern image / geom. def. string ?	inactive:grooves 4 10 20 40 60 80	×Q
rim data file ?	n/a	×Q
sidewall texture image ?	n/a	×Q
rim graphics (CAD) file ?	n/a	×Q
car-body graphics (CAD) file ?	n/a	×Q
sound file ?	n/a	×Q
user library path ?	n/a	×Q

Figure 23: cosin/tools for tires linked files menu

2.17 Animation & Sound

The animation and sound settings menu (shown in figure 24) lists all **FTire** animation settings. In the top section, the animation output type can be defined. Current options include:

- none, to disable the animation output and all other animation related output;
- on-line, to enable the animation output. For efficiency reasons, not all animation features are available in the accelerated speed modes. The on-line animations are by default disabled for all real-time speed modes. For real-time debugging purposes, the animation output can be enabled by activating the option 'if ordered, write output files and show animation even in real-time mode' (edit>output>diagnostics). Additional settings for this option can be activated with the following check-boxes:
 - full screen, to enable the full-screen animation output;
 - enable in 3rd-party env., to output the animation, even if suppressed by certain calling solvers in 3rd-party environments;
- on-line + movie, to activate the animation output and simultaneously create a movie file. The following codecs are available (if supported by the user environment):
 - mp4, create movie in mp4 (MPEG-4) codec, compatible with VLC, QuickTime, Windows Media Player;
 - lossless, create movie in ffv1 lossless archiving codec, compatible with VLC and Windows Media Player;
- on-line + ogl file, to activate the animation output and simultaneously record a off-line animation file (ogl-file). The ogl-file can be used to play back the simulation off-line in the cosin/player or 3rd-party post-processors;
- on-line + frame list (bmp), to activate the animation output and simultaneously create a sequence of bitmap(bmp) files;
- only ogl-file, to only output the off-line animation file (ogl-file);

The bottom part of the animations menu lists sub-menus that control the animation output. The sub-menus are:

• scene (pg. 23)

- tire surface (pg. 27)
- sidewall (pg. 28)
- footprint (pg. 29)
- scopes (pg. 30)
- rim (pg. 31)
- road (pg. 32)
- car-body (pg. 33)
- decoration (pg. 34)
- sound (pg. 35)

Selecting the \bigcirc (loupe button), in the bottom right corner of the animation menu window, will open a animation window and visualize the current animation settings (if the tire data does not contain valid pre-processed data, it may take a while before the animation window is shown).

Animati	on settings in defa	ult.tir	(autosave)														
le Outrou	t Help	uncircuit	(00000000															
ie outpu	e nep																	
kind of an	imation output																	
Ffire/si	m will use its own an	matic	on output s	electio	n													
	none	е -	_		_													
	on-line	(•	∫ fu	ll scree	en 📘	enable	e in 3r	d-party	env.									
	on-line + movie	C	• m	p4 C	lossles	s												
	on-line + ogl-file	C																
on-lin	ne + frame list (bmp)	C																
	only ogl-file	C																
scene	tire surface	side	wall f	footpri	int	scop	es	rim	roa	d	car-bo	ody	annotatio	n	soun	d		
	animation time st	ep ?	0.001	s	start		0	s	end		999	s						
ar	nimation window wid	th ?	320	mm	height		180	mm										
	footprint plot x-p	os ?	0	mm	y-pos		999	mm	size		50	mm						
	scopes x-p	os ?	999	mm	y-pos		999	mm	size		50	mm						
	rim force componen	ts 🧿	disable	C	show													
	running diagram	ns 📀	disable	0	Fx, Fy	/, Fz	C	Mx, My	, Mz	C	Fx, Fy, Mz	C	general sco	es				
force d	liagrams magnificatio	on ?	1	1														
scaling	g of forces in diagram	ns ?	1															
running	diagrams time interv	/al ?	10	s														
	sensor locatio	ns 💽	disable	0	show													
	vecto	rs C	disable	•	cont.	force	sC	cont.d	tispl.	C	belt dirs	C	rim flange fo	rce	;			
scaling o	of force/displ. vecto	rs ?	1	•														
	control slide	rs 🖲	disable	C	std		C	std sma	əll	C	op cond	C	op cond sma	L C	all		0	all small
	color palet	te C	gray scal	e C	therm	10	ſ	red. th	ermo	C	VGA	C	rainbow	C	green	red	C I	blue/red
	camera foc	us 🕫	wheel ctr	r C	cont	patch	C	mole's v	view	C	rim-fixed	C	glass plate	C	origin		0	cp full win
c	amera distance to r	im ?	8	m	azim.		15	deg	elev.		2	deg						
	extra camera shift	×?	0	m	У		0	m	z		0	m						
		V	perspect	ive pro	jection													
		Г	no lightin	g														
	sun position	× ?	-10	m	у		5	m	z		0.5	m						
5															ok	can	icel	apply

Figure 24: cosin/tools for tires animation settings menu: scene

The scene sub-menu (shown in figure 24) lists all settings that control the animation scene. The following settings are available:

- animation time, defining the animation output duration and step size. The following entry fields are available:
 - time step, animation output step size. If the defined animation step size is smaller than the internal solver step size, the internal solver step size will be used instead;
 - start time, animation output start time;
 - end time, animation output end time;
- animation window size, defining the on-line animation window size with the following entries:
 - window width, on-line animation widow width;
 - window height, on-line animation window height;
- **footprint plot position**, defining the footprint plot position in the animation window with the following entries:
 - x-position, x-position of the bottom left corner of the footprint plot. If the position is on the outside of the defined animation window, the closest position that is located on the animation window will be chosen;
 - y-position, y-position of the bottom left corner of the footprint plot. If the position is on the outside of the defined animation window, the closest position that is located on the animation window will be chosen;
 - size, the size of the footprint plot;
- scopes position, defining the position of the scopes in the animation window with the following entries:
 - x-position, x-position of the bottom left corner of the scope. If the position is on the outside of the defined animation window, the closest position that is located on the animation window will be chosen;
 - y-position, x-position of the bottom left corner of the first scope. If the position is on the outside of the defined animation window, the closest position that is located on the animation window will be chosen;
 - size, the size of the scope;
- rim force components, radio-buttons to show/hide the rim force components;
- running diagrams, radio-buttons defining which running diagrams or scopes should be shown during the animation. The running diagrams may require information that is saved to the additional plot output file. To generate the additional plot output file go to edit>output>output files>plot file and select the extended, ascii option. The following running diagrams are available:
 - disable, to hide all diagrams during the animation;
 - Fx, Fy, Fz, to display the three tire force components in a running diagram;
 - Mx, My, Mz, to display the three tire moments in a running diagram;
 - Fx, Fy, Mz, to display the handling relevant tire forces and moment in a running diagram;

- general scopes, to display the defined scopes in a running diagram/s (see figure 28);

- force diagram magnification, force diagrams magnification factor. The scope size will be multiplied with this magnification factor;
- force diagram scaling, the force diagrams scaling factor is used to scale the rim force components;
- running diagrams time interval, plot time interval to be used in the running diagrams;
- sensor locations, radio-buttons to show/hide the sensor locations;
- vectors, radio-buttons defining the vector output during animations. The following options are available:
 - disable, to hide all display vectors during animations;
 - cont. forces, to display contact force vectors. Contact forces will be shown for each contact element, either in red, orange or in yellow. A red color indicates that the element is sticking to ground, an orange color indicates that the element is starting to slide but has not reached the maximum friction level, whereas a yellow color indicates that the element is sliding;
 - cont. displ, to display contact element displacement vectors. Contact element displacements will be shown for each contact element, either in red, orange or in yellow. A red color indicates that the element is sticking to ground, an orange color indicates that the element is starting to slide but has not reached the maximum friction level, whereas a yellow color indicates that the element is sliding;
 - belt dirs, to display the belt direction. Belt directions will be shown for all belt elements;
 - rim flange forces, to display the rim contact force vectors. Rim contact force vectors will be shown for each contact element. The contact force vectors will be displayed in red if the internal force is at least 50% larger than the centrifugal force of the free tire mass. If this condition is not met then the contact forces will be shown in blue;
- scaling of force/displ. vectors, the factor is use to scale the contact force /rim flange force/contact displacement vectors;
- control sliders, radio-buttons defining the set of sliders that are shown during the animation. The sliders control, among others, scaling factors and the tire graphics resolution. The following options are available:
 - disable, to hide all control sliders during animations;
 - std, to display the standard set of control sliders during the animation;
 - std small, to display a smaller version of the standard set of control sliders during the animation;
 - op cond, to display only the set of control sliders that control the output conditions during the animation;
 - op cond small, to display a smaller version of the set of control sliders that control the output conditions;
 - all, to display all available control sliders during the animation;

- all small, to display a smaller version of all available control sliders during the animation;
- color palette, radio-buttons defining the color palette that is used in the footprint plot. The following color palettes are available:



- camera focus, radio-buttons defining the camera focus point. The following options are available:
 - wheel ctr, to focus the camera on the wheel center;
 - cont patch, to focus the camera on the contact patch;
 - mole's view, to view the scene from above;
 - rim-fixed, to move the camera with the rim;
 - glass plate, to view the scene from below;
 - origin, to focus the camera on the origin;
 - cp full win, to display only the footprint plot in the animation window;
- camera position, defining the camera position relative to the rim. The following entry fields are available:
 - distance to rim, to set the camera distance to the rim;
 - azim., to set the azimuth camera view angle;
 - elev., to set the elevation(altitude) camera view angle;
- extra camera shift, defining an additional camera shift. The following entry fields are available:
 - shift x, to shift the camera in the x-direction;
 - shift y, to shift the camera in the y-direction;
 - shift z, to shift the camera in the z-direction;
- scene projection, defining the projection mode during the animation. The default projection mode (no selection is made) is the orthographic (or parallel) mode; if the check box is however marked, then the perspective projection mode will be used instead;
- lighting, defining the lighting mode during the animation. The default lighting mode (no selection is made) is the ON mode; if the the check box is however marked, then the lighting will be switched OFF;

- sun position, defining the light source (sun) position. The following entry fields are available:
 - position x, to set the x-position of the light source;
 - position y, to set the y-position of the light source;
 - **position z**, to set the z-position of the light source;

C Animation settings in _default.tir (autosave)	×
File Output Help	
kind of animation output	
FTire/sim will use its own animation output selection	
none C	
on-line 🤄 🦵 full screen 🦵 enable in 3rd-party env.	
on-line + movie C	
on-line + ogl-file	
on-line + frame list (bmn)	
only califie C	
scene tire surface sidewall footorint scopes rim road car-body apportation sound	
seene seene sheeraa iooprine seepes riin roud euroody annoudon sound	
tire surface 📀 rendered as rubber	
C wire frame	
C colorizad: surface temperature	
Countrates the advertise	
Colorized: structure distortion	
C colorized: air pressure distribution	
C colorized: air flow distribution	
# nodes long. 0 # nodes lat. 0	
C ok cancel	apply

Figure 25: cosin/tools for tires animation settings menu: tire surface

The **tire surface** sub-menu (shown in figure 25) lists all settings that control the rendering of the tire in the animation. The following settings can be set:

- tire surface, radio-buttons defining the rendering of the tire structure. The following options are available:
 - render as rubber;
 - wire frame;
 - colorized: surface temperature;
 - colorized: tread wear;
 - colorized: structure distortion;
 - colorized: air pressure distribution;
 - colorized: air flow distribution;
- # nodes, defining the rendering resolution of the tire structure. The following entry fields are available:
 - long., defining the number of nodes in the longitudinal direction. Set to 0 for default values;
 - lat., defining the number of nodes in the lateral direction. Set to 0 for default values;

• **temperature scale final value**, defining the value of the maximum temperature to be used in the color scale;

C Animation settings in _default.tir (autosa	e)	×
File Output Help		
kind of animation output		
FTire/sim will use its own animation output	selection	
none C		
on-line 🚱 🔲	full screen 🦵 enable in 3rd-party env.	
on-line + movie C G	mp4 C lossless	
on-line + ogl-file		
on-line + frame list (bmp)		
only califie C		
only ogenite k		
i i i i i i i i i i i i i i i i i i i		
scene tire surface sidewait	rootprint scopes rim road car-body annotation sound	
	Carte C fits astro-balance	
sidewall texture () none	auto (* me, enter below	~ _
sidewall texture image ?	n/a ,	~ `
texture transparency threshold ? 99	8 	
texture scaling ? 100	* 	
texture aspect ratio correction ? 100	%	
texture radial shift ? 0	8	
# texture repetitions ? 1		
Q	ok cancel	apply

Figure 26: cosin/tools for tires animation settings menu: sidewall

The **sidewall** sub-menu (shown in figure 26) lists all settings that control the rendering of the tire sidewall in the animation. The following settings can be set:

- tire surface, radio-buttons defining the sidewall marking. The following options are available:
 - none, to hide all tire markings;
 - auto, to display the alphanumeric tire identification code;
 - file, to us the defined image file as sidewall marking;
- sidewall texture image file, to define the sidewall texture image file that should be used;
- texture transparency threshold, to define the pixel transparency threshold:
 - positive threshold pixels lighter than threshold are set to transparent;
 - negative threshold pixels darker than threshold are set to transparent;
- texture scaling, to define a percentual resize scaling factor of the texture image;
- texture aspect ratio correction, to define a texture aspect ratio correction factor. If the correction factor is:
 - smaller than 100% the width of the image will increase;
 - larger than 100% the width of the image will decrease;
- texture radial shift, to define a radial shift, relative to the sidewall hight, of the sidewall texture. If the shift is:
 - positive the shift is outward, away from the rim center;
 - negative the shift is inward, towards the rim center;

• # texture repetitions, to define the number of texture repetitions in circumferential direction;

C Animati	on settings in _de	fault.tir (autos	ave)								×
File Outpu	т нер										
kind of an	imation output										
FTire/si	m will use its own a	animation outp	ut selection								
	nor	ne C									
	on-lir	ne 🖲 🗆	full screen	enable in 3	rd-party	env.					
	on-line + mov	ie C 🤅	mp4 C lossl	ess							
	on-line + ogl-fi	ile C									
on-lir	ne + frame list (bmj	p) 🔿									
	only ogl-fi	ile C									
scene	tire surface	sidewall	footprint	scopes	rim	road	car-body	annotation	sound		
	footprint	plot C disable max. C max. C max. C max. C frictis C sliding C tread C tread C mean	e contact pressu longitudinal she lateral shear st on coefficient d g velocity ce temperature i depth i power loss den contact pressu	re ar stress ress iistribution distribution sity re							
	footprint loca	ation 🗭 separ	ately in image								
		C real p	osition at tire								
mm co	ontour plot / mm in	nage? 2									
୍									ok	cancel	apply

Figure 27: cosin/tools for tires animation settings menu: footprint

The **footprint** sub-menu (shown in figure 27) lists all settings that control the footprint plot in the animation. The following settings can be set:

- **footprint plot**, radio-buttons to show/hide the various footprint plots during the animation. The following options are available:
 - disable, to hide the footprint plot;
 - contact pressure, to show the current tire contact pressure distribution;
 - longitudinal shear force, to show the current longitudinal shear stress in the contact patch;
 - lateral shear force, to show the current lateral shear stress in the contact patch;
 - friction coefficient, to show the current friction coefficients of the contact elements;
 - sliding velocity, to show the current sliding velocity of the contact elements;
 - temperature, to show the current temperature of the contact elements;
 - tread depth, to show the current tread depth of the contact elements;
 - power loss, to show the current power loss in the contact patch;
- footprint location, radio-buttons to define the location where the plot is shown. The following options are available:

- separately in image, to display the footprint plot in the animation window. The location is defined in the scene options tab;
- real position at tire, to render the footprint plot to the the tire surface;
- **mm contour plot** / **mm image**, to define the factor that scales the size of the contact patch, if shown in the full window mode. It specifies the true size of contact patch relative to the shown size, in terms of an integer number.



Figure 28: cosin/tools for tires animation settings menu: scopes

The **scopes** sub-menu (shown in figure 28) lists settings that define the general scopes in the animation. A maximum of three scopes can be defined. The following settings can be set:

- entry fields defining the scopes, the following entry fields need to be defined:
 - ? (help button), to display the instructions on how to define the scopes;
 - y-axis plot signal, entry field to define the y-axis plot signal. Select the entry field with the left mouse button and then select the required plot signal from the 'Plot signals' window. The entry field will automatically be filled with the relevant information;
 - min, to specify the minimum y-axis value. A blank field sets the scaling to 'auto-scaling';
 - max, to specify the maximum y-axis value. A blank field sets the scaling to 'auto-scaling';
 - x-axis plot signal, entry field to define the x-axis plot signal, the default is 'time, s'. Select the entry field with the left mouse button and then select the required plot signal from the 'Plot signals' window. The entry field will automatically be filled with the relevant information;
 - min, to specify the minimum x-axis value. A blank field sets the scaling to 'auto-scaling';

- max, to specify the maximum x-axis value. A blank field sets the scaling to 'auto-scaling';
- X (clear button), to clear all the entry fields of the scope;
- prefer multi-signal scope, combines all defined scoped into a single plot.

C Animation settings in _default.tir (autosave)	×
File Output Help	
kind of animation output	
FTire/sim will use its own animation output selection	
none C	
on-line 🙃 🗖 full screen 🗖 enable in 3rd-party env	
an line i mauje C C med C lassier	
on-une + og-me (
on-line + frame list (bmp) C	
only ogi-file C	
scene tire surface sidewall footprint scopes rim road car-body annotation sound	
rim graphics (CAD) file ? n/a	×Q
rim surface 🕝 rendered	
C colorized: radial forces	
C colorized: lateral forces	
C colorized: radial elastic displacement	
C colorized: lateral elastic displacement	
C colorized: radial plastic deformation	
C colorized: lateral plastic deformation	
rim paint gray scale ? 0 % 0 aluminum 100 black painted	
ok cancel	арріу

Figure 29: cosin/tools for tires animation settings menu: rim

The **rim** sub-menu (shown in figure 29) lists all settings that control the rendering of the rim in the animation. The following settings can be set:

- rim graphics file, entry field defining the rim CAD file. The following buttons are available:
 - ? (help button), to open the relevant help documentation;
 - X (clear button), to clear the entry field;
 - ••• (browse button), to select the rim graphics file from a file browser;
 - \mathbb{Q} (loupe button), to view the rim graphics file in the cosin/CADbrowser;
- rim surface, radio-buttons controlling the rim surface render settings. The following options are available:
 - rendered;
 - colorized: radial forces;
 - colorized: lateral forces;
 - colorized: radial elastic displacement;
 - colorized: lateral elastic displacement;
 - colorized: radial plastic deformation;

- colorized: lateral plastic deformation;
- rim paint gray scale, scaling factor controlling the rendered color of the rim. Setting the value to 0% will result in an aluminum finish while setting the value to 100% will result in a black paint finish.

C Animation settings in _default.tir (autosave)	×
File Output Help	
kind of animation output	
FTire/sim will use its own animation output selection	
none C	
on-line 🤄 🦵 full screen 🦵 enable in 3rd-party env.	
on-line + movie C	
on-line + ogl-file C	
on-line + frame list (bmp) C	
only ogl-file C	
scene tire surface sidewall footprint scopes rim road car-body annotation sound	
road visualization istable rendered surface, following wheel rendered surface, pinned to ground rendered surface, autoscaled rendered surface, autoscaled rendered surface, autoscaled rendered surface, autoscaled rendered surface, autoscaled rendered to ground rendered to ground re	
C Cancel app	ly

Figure 30: cosin/tools for tires animation settings menu: road

The **road** sub-menu (shown in figure 30) lists all settings that control the rendering of the road in the animation. The following settings can be set:

- road visualization, radio-buttons controlling the road surface render settings. The following options are available:
 - disable;
 - rendered surface, following wheel, grey scale color palette is used;
 - rendered surface, pinned to ground, grey scale color palette is used;
 - rendered surface, autoscaled, reduced thermo color palette is used;
 - grid surface, following wheel, grey scale color palette is used;
 - grid surface, pinned to ground, grey scale color palette is used;
 - grid surface, autoscaled, grey scale color palette is used;
 - double line, single black line per tire instance;
 - road type specific, prefer rendered;
 - road type specific, prefer grid;
- grid size, to define the visualized road grid size:

- x, defining the length of the visualized road;
- y, defining the width of the visualized road;
- grid line distance, to define the grid resolution:
 - \mathbf{x} , defining the x line spacing;
 - y, defining the y line spacing;

C	Animatio	n settings in _de	fault.tir (autos	ave)								×
File	Output	Help										
ki	nd of anin	nation output										
	FTire/sim	will use its own a	animation outp	ut selection								
		non	ie C									
		on-lin	e 🕶 🗆	full screen 🎵	enable in 3	rd-party	env.					
		on-line + movi	ie O 🧿	mp4 C loss	less							
		on-line + ogl-fi	le C									
	on-line	+ frame list (bmp	D) (C									
		only ogl-fil	le C									
	scene	tire surface	sidewall	footprint	scopes	rim	road	car-body	annotation	sound		
	car-body g	raphics (CAD) file	e ?				n/a	a				×Q
	car-body	point of referenc	e: x ? n/	a m y	n/a	m	z n/a	a m				
0										ok	cancel	apply

Figure 31: cosin/tools for tires animation settings menu: car-body

The **car-body** sub-menu (shown in figure 31) lists all settings that control the rendering of the car-body in the animation. The following settings can be set:

- car-body graphics file, entry field defining the rim CAD file. The following buttons are available:
 - -? (help button), to open the relevant help documentation;
 - X (clear button), to clear the entry field;
 - ••• (browse button), to select the car-body graphics file from a file browser;
- car-body point of reference, to define the car-body reference point with:
 - x, defining the reference location along the x-axis;
 - y, defining the reference location along the y-axis;
 - z, defining the reference location along the z-axis;

	on s	ettin	gs in	_defa	ult.tir (a	utos	ave)							
le Outpu	ıt	Help												
kind of ar	ima	tion o	outpu	ıt										
FTire/s	im w	ill use	its o	wn ani	imation	outpu	ut selection							
				none	С									
			0	n-line	•	Г	full screen	🖵 enable in 3	rd-party	env.				
		on-li	ne + i	movie	c	Ģ	mp4 C los	sless						
		on-lir	ne + o	gl-file	c									
on-li	ne +	frame	e list	(bmp)	c									
			only o	d filo	~									
			onty o	gi-nie	0									
scene		tire si	urfac	e	sidew	all	footprint	scopes	rim	road	car-body	annotation	sound	
scene		tire si	urfac	e	sidew	all	footprint	scopes	rim	road	car-body	annotation	sound	
scene text #1:	×	tire si	urfac y	e 0.0	sidew color	all 0	footprint	scopes	rim text	road	car-body	annotation	sound	×
scene text #1: text #2:	×	tire si 0.0	urfac y y	e 0.0	sidew color color	all 0 0	footprint	scopes	rim text text	road	car-body	annotation	sound	×
scene text #1: text #2:	××××	0.0	y y y y	e 0.0 0.0	color color	all 0 0	footprint	scopes	rim text text	road	car-body	annotation	sound	×
scene text #1: text #2: text #3:	× × ×	0.d 0.0 0.0	y y y y y	e 0.0 0.0 0.0	color color color	all 0 0	footprint	scopes	rim text text text	road	car-body	annotation	sound	× × ×
scene text #1: text #2: text #3: text #4:	× × × ×	0.0 0.0 0.0 0.0	y y y y y y	0.0 0.0 0.0 0.0	color color color color	all 0 0 0	footprint fo small (fo small (fo small (fo small (fo small ()	scopes large font large font large font large font large font	rim text text text text	road	car-body	annotation	sound	× × × ×
scene text #1: text #2: text #3: text #4:	x x x x	0.d 0.0 0.0 0.0	y y y y y	e 0.0 0.0 0.0	sidew color color color	all 0 0 0	footprint (small ((small ((small ((small ((small (scopes large font large font large font large font large font large font	rim text text text text	road	car-body	annotation	sound	× × ×
scene text #1: text #2: text #3: text #4:	× × × ×	0.0 0.0 0.0 0.0	y y y y y	0.0 0.0 0.0	sidew color color color	all 0 0	footprint c small (c small (c small (c small (c small (scopes large font large font large font large font large font	rim text text text text	road	car-body	annotation	sound	× × ×
scene text #1: text #2: text #3: text #4:	× × × ×	0.0 0.0 0.0	y y y y y	e 0.0 0.0 0.0	sidew color color color	all 0 0	footprint (small ((small ((small ((small ((small (scopes	rim text text text text	road	car-body	annotation	sound	××××××

Figure 32: cosin/tools for tires animation settings menu: decoration

The **decoration** sub-menu (shown in figure 32) lists all settings that define optional text that should be displayed during the animation. The following settings can be set:

- text, to specify up-to three user-defined strings as decoration. The following fields need to be defined:
 - \mathbf{x} , defining the x starting position of the decoration;
 - y, defining the y starting position of the decoration;
 - color, defining the color of the decoration;
 - font size, defining the font-size of the decoration;
 - text, defining the string that should be displayed as decoration;
 - X (clear button), to clear the text entry fields;

C Animation settings in _default.tir (autosave)		×
File Output Help		
kind of animation output		
FTire/sim will use its own animation output selection		
none C		
on-line 🤄 🦵 full screen 🦵 enable in 3rd-party env.		
on-line + movie C G mp4 C lossless		
on-line + ogl-file C		
on-line + frame list (bmp)		
only ogi-file C		
scene tire surface sidewall footprint scopes rim road car-body annotation	sound	
enable sound		
sound file ? ftire/param/ft1.wav		×Q
~	ok cancel	apply

Figure 33: cosin/tools for tires animation settings menu: sound

The **sound** sub-menu (shown in figure 33) lists all settings that define the tire sound of the animation. The following settings can be set:

- enable sound, check-box to enable the sound;
- sound file, entry field defining the rim sound file. The following buttons are available:
 - -? (help button), to open the relevant help documentation;
 - X (clear button), to clear the entry field;
 - ••• (browse button), to select the sound file from a file browser;
 - (loupe button), to view the sound file with a media player;

2.18 Output

The output settings menu (shown in figure 34) lists all settings that control the **FTire** result file and other outputs. The menu is divided into four sub-menus. The sub-menus are:

- output files (pg. 35)
- diagnostics (pg. 39)
- sensor signals (pg. 40)
- pre-processing control (pg. 41)

C Output reque	sts: _default.tir (a	utosave)				×
File Output H	elp					
output files	diagnostics	sensor signals	pre-processing control			
	plot file (mtl/r	ntb)? In Ca	td. ascii C extended. ascii	C std, binary C extended, binary	file name given in 3rd-party environment	
contact pat	ch details outp. (cfo)? no C y	es			
contact patch	boundary outp. (spo) ?⊙ no⊙y	es			
tread st	ates output (gpo	,) ? • no • n	ax. ground pressure C ma	x. long. shear stress 🔿 max. lat. shear stress		
		C m	ean ground pressure C mea	an long, shear stress 🔘 mean lat, shear stress		
		resolution	0 mm			
structure ge	eometry output (j	geo)? 🖲 no 🤇 a	sc C bin C shl C obj			
		resolution	10 mm (long)	10 mm (lat)		
		coordinate system		wheel-carrier-fixed		
		layer	C surface 🗭 belt/carca	ss C inner liner C effective TPMS location		
		rotating	-			
		add. attributes				
belt and ri	n states output (bso)? O no C r	otating cartesian C rotati	ng cylindrical		
tread	d depths output (tdo)? © no C y	es			
wheel	envelope output	(shl)? I no C y	es			
	rgr file output (rgr)?? (€ no (C y	es, auto-size C 3.2 MB C	10 MB (* 32 MB (* 100 MB (* 320 MB (* 1 GE	3	
	output time :	step ? 0.	s			
	output s	tart ? 0.0	s end ? 999.0 s			
					ok cancel undo appl	У

Figure 34: cosin/tools for tires output specification menu

The **output files** sub-menu (shown in figure 34) lists all settings that define the result file output during a **FTire** simulation. If an output option is selected, then the output file name, given in a 3rd-party environment, is show in blue on the left-hand side of the output files menu. The sample file name and

file extension are shown. The 'x', in the file name, is a placeholder for the tire instance (one output file will be generated per tire instance). The following settings can be set in the menu:

- plot file (mtl/mtb), radio-buttons to generate additional plot output files (one per tire instance) with FTire states and other output signals. The following options are available:
 - no, to disable the plot file output;
 - std, ascii, to output the most important plot signals, saved in a Matlab-compatible ascii-file (.mtl);
 - extended, ascii, to output all available plot signals, saved in a Matlab-compatible ascii-file (.mtl);
 - std, binary, to output the most important plot signals, saved in a Matlab-compatible binaryfile (.mtb);
 - extended, binary, to output all available plot signals, saved in a Matlab-compatible binaryfile (.mtb);
- contact patch details output (cfo), radio-buttons to generate extra output files containing the distributed ground contact forces and several state variables of the tread, for further user-specific post-processing purposes. The following options are available:
 - no, to disable the contact patch details output;
 - yes, to output the distributed ground contact forces and several state variables of the tread, saved in Matlab-compatible ascii-file;
- contact patch boundary output (cpo), radio-buttons to generate extra output files containing the containing the contact patch boundary data points, for further user-specific post-processing purposes. The output files consist of a sequence of (n_boundary_data_points × 2)-matrices, each containing the contact patch boundary data points at the simulation time written in the respective matrix head-line (for example: % time=0.1 112 boundary data points). The following options are available:
 - no, to disable the contact patch details output;
 - yes, to output the contact patch boundary data points, saved in Matlab-compatible ascii-file;
- tread states output (gpo,...), radio-buttons to generate extra output files containing tread state values, interpolated onto a regular and uniform grid. The output files consist of a sequence of (nx × ny)-matrices, each containing tread state values at the simulation time written in the respective matrix head-line (for example: % time=0.1 dx=0.0032 dy=0.0032 nx=101 ny=101). The tread state values are given in [MPa] over a regular (equally spaced) grid with nx × ny grid points (101 x 101 in this example), centered to wheel coordinates, with grid line distances as specified in the header-line (3.2 mm both for x and y in this example). The following tread state outputs are available:
 - no, to disable the contact patch details output;
 - max. ground pressure, to output the interpolated maximum ground pressure, saved in a Matlab-compatible ascii-file (.gpo);

- mean ground pressure, to output the interpolated mean ground pressure, saved in a Matlabcompatible ascii-file (.gpo);
- max. long. shear stress, to output the interpolated maximum longitudinal shear stress, saved in a Matlab-compatible ascii-file (.sxo);
- mean long shear stress, to output the interpolated mean longitudinal shear stress, saved in a Matlab-compatible ascii-file (.sxo);
- max. lat. shear stress, to output the interpolated maximum lateral shear stress, saved in a Matlab-compatible ascii-file (.syo);
- mean lat. shear stress, to output the interpolated mean lateral shear stress, saved in a Matlab-compatible ascii-file (.syo);
- resolution, entry field to define the grid spacing of the regular output grid;
- structure geometry output (geo), radio-buttons to generate extra output files containing the actual, distorted carcass and belt geometry for further user-specific post-processing purposes. The following options are available:
 - no, to disable the contact patch details output;
 - asc, to output the permanent tire geometry, saved in a Matlab-compatible ascii-file (.geo);
 - bin, to output the permanent tire geometry, saved in a Matlab-compatible binary format (.geo);
 - shl, to output the most recent tire geometry, saved as a shel (.shl);
 - obj, to output the most recent tire geometry, saved as a object (.obj);
 - resolution, to define the approximate lateral and longitudinal output resolution;
 - coord. system, radio-buttons defining the output coordinate system. The following options are available:
 - * global;
 - * rim-fixed;
 - * wheel-carrier-fixed;
 - layer, to define the geometry output layer. The following options are available:
 - * belt/carcass;
 - * surface;
 - * inner liner;
 - * eff. TPMS loc. (effective TPMS sensor location);
 - rotating, if selected the axis system is rotating with the tyre;
 - add. attributes, check-box to enable/disable the output of additional nodal states. These
 attributes can for example be used for tire structure coloring proposes. If enabled the following
 attributes will be saved to the structure geometry file (ascii and bin output only):

- * local tread depth;
- * local surface temperature;
- * local structure distortion;
- * local air pressure distribution;
- * local air flow distribution;
- belt states and forces output (bso), radio-buttons to generate extra output files containing additional, belt-state related output signals, together with the circumferentially distributed interfacial forces between the sidewalls and the rim flanges, for further user-specific post-processing purposes. The following options are available:
 - no, to disable the belt states and forces output;
 - yes, to output the belt-state related output signals, saved in a Matlab-compatible ascii-file (.bso);
- tread depths output (tdo), radio-buttons to generate extra output files containing the tread depths of all contact elements, for further user-specific post-processing purposes. The tread depth output values include the tread base height. The following options are available:
 - no, to disable the tread depths output;
 - yes, to output the tread depths, saved in a Matlab-compatible ascii-file (.tdo);
- wheel envelope output (shl), radio-buttons to generate extra output files containing the current wheel envelope, for further user-specific post-processing purposes. The following options are available:
 - no, to disable the wheel envelope output;
 - yes, to output the wheel envelope, saved as a shell (.shl);
- rgr file output output (rgr), radio-buttons to generate rgr road data. The bounds of the rgr domain rectangle in x/y-plane are determined by the area covered by the respective wheel during simulation. As an example, these rgr files can be used when replaying the simulation outside the 3rd-party environment, where the original road evaluation library might not be available. The following options are available:
 - no, to disable the wheel envelope output;
 - yes, to output the road output, saved as a regular grid road data file (.rgr). rgr-file size can be limited to:
 - * auto-size
 - * 3.2MB
 - * 10MB
 - * 32MB
 - * 100MB

* 320MB

* 1GB

- output time step, approximate time step for the additional output of the plot signals, contact forces, and belt states. Note that FTire does not interpolate any output signals, nor, for efficiency reasons, does it try to exactly match the desired time step. For these reasons, the actual output steps might slightly differ from this value. Output time step is to be specified in the data file's time unit. If zero or not specified, each successful integration step will be saved;
- **output start**, approximate simulation time to begin the additional output. If not specified, the output (if requested) will begin with the simulation;
- **output end**, approximate simulation time to end the additional output. If not specified, the output will end with the simulation;

ts: _default.tir (au	itosave)			×
diagnostics	sensor signals	pre-processing control		
ation recording 🕯	?⊙noCyes (C extended	file name given in 3rd-party	environment
message output f state animation f atics animation f	? € std C verbo ? € no C yes ? € no C yes	se	ftire.msg	
	ts: _default.tir (au p diagnostics ation recording ? message output ? state animation ? atics animation ?	ss:default.tir (autosave) p diagnostics sensor signals ation recording ? © no C yes (message output ? © std C verbu state animation ? © no C yes atics animation ? © no C yes	ip diagnostics sensor signals pre-processing control ation recording ? C no C yes C extended message output ? C std C verbose state animation ? C no C yes atics animation ? C no C yes	ss:default.tir (autosave) p diagnostics sensor signals pre-processing control file name given in 3rd-party ation recording ? o no yes c extended message output ? o std verbose ftire.msg state animation ? o no yes atics animation ? o no yes

Figure 35: cosin/tools for tires output specification menu

The **diagnostics** sub-menu (shown in figure 35) lists all settings that can be used for troubleshooting a **FTire** simulation failure. If an output option is selected, then the output file name, given in a 3rd-party environment, is show in blue on the left-hand side of the output files menu. The following options are available:

- simulation recording, radio-buttons to generate a file which enables the analysis and exact 'replay' of the current FTire simulation. The following options are available:
 - no, to disable the simulation recording output;
 - yes, to save all information that is required to replay the FTire simulation, saved in a Matlabcompatible binary-file (ftire.rec);
 - extended, to save a comprehensive set of information to replay the FTire simulation, saved in a Matlab-compatible binary-file (ftire.rec). When this option is selected, the rec-file might become very large in size. This option is only required for debugging in certain special cases;
- message output, radio-buttons to set the log-file message detail level. The following options are available:
 - std, to define the standard message output, saved in the log file (.log);
 - verbose, write extra messages to the message and log file;

- **steady-state animation**, radio-buttons to disable/enable the animation output during steady-state simulations. The following options are available:
 - no, to disable the steady-state animation output;
 - yes, to enable the steady-state animation output;
- statics animation, radio-buttons to disable/enable the animation output during statics. The following options are available:
 - no, to disable the statics animation output;
 - yes, to enable the statics animation output;
- if ordered, write output files and show animation even in real-time mode, check-box that defines the animation output if called in real-time mode. If selected the FTire animation will be shown. For efficiency reasons the on-line animations are by default disabled for all real-time speed modes and should only be activated for debugging purposes.

utput files	diagnostics	se	nsor	signals	pre-process	ing control							
create sens	or signal 1:	kind	5	□ at	deformed tire	☐ rotating	☐ trace	circumf.angle	0	deg	y-coord	-80	mm ×
create sens	or signal 2:	kind	5	🖵 at	deformed tire	☐ rotating	☐ trace	circumf. angle	0	deg	y-coord	0	mm ×
create sens	or signal 3:	kind	5	🖵 at	deformed tire	☐ rotating	☐ trace	circumf. angle	0	deg	y-coord	80	mm ×
create sens	or signal 4:	kind	0	🕅 at	deformed tire	rotating	☐ trace	circumf. angle	0	deg	y-coord	0	mm ×
create sens	or signal 5:	kind	0	🕅 at	deformed tire	rotating	☐ trace	circumf. angle	0	deg	y-coord	0	mm ×
create sens	or signal 6:	kind	0	🔲 at	deformed tire	rotating	☐ trace	circumf. angle	0	deg	y-coord	0	mm ×
create sens	or signal 7:	kind	0	🔲 at	deformed tire	☐ rotating	☐ trace	circumf. angle	0	deg	y-coord	0	mm ×
create sens	or signal 8:	kind	0	🗖 at	deformed tire		☐ trace	circumf. angle	0	deg	y-coord	0	mm ×
create sens	or signal 9:	kind	0	∏ at	deformed tire		☐ trace	circumf. angle	0	deg	y-coord	0	mm ×
create sens	or signal 10:	kind	0	∏ at	deformed tire		☐ trace	circumf. angle	0	deg	y-coord	0	mm ×

Figure 36: cosin/tools for tires output specification menu

The **sensor signals** sub-menu (shown in figure 36) lists up-to 10 sensors, that can be defined by the user, to output additional information during a **FTire** simulation. The following options are available:

- activation tick-box, to activate the sensor. The sensor signal number is also shown;
- kind, entry field to specify the type of sensor. The sensors type is defined by a number, zero (0) indicated that the sensor is not used. The following types are available:
 - 1. normal deflection;
 - 2. longitudinal shear displacement;
 - 3. lateral shear displacement;
 - 4. tread height;
 - 5. surface temperature;
 - 6. stick/slip state;

- at deformed tyre, check box to specify the sensor location relative to the tire. If selected the sensor is fixed to the deformed tyre surface. If not selected the sensor position is fixed relative to the rim is used;
- rotating, check-box to define wether or not the sensor is rotating with the tyre/rim, or if the sensor is fixed relative to the wheel carrier;
- trace, check-box to hide/show a trace, of the sensor location, in the animation;
- circumf. angle, to specify the circumferential angle where the sensor should be located. If the sensor is not rotating, or during the initial conditions, then the orientation is defined as follows
 - Odeg, bottom / center of tire contact patch;
 - 90deg, foremost position;
 - 180deg, topmost position;
 - 270deg, rearmost position;
- y-coord, to define the lateral position of the sensor. Zero indicates the center of the belt. Negative coordinate values are to the left of the belt center while positive values are located to the right.
- X (clear button), to clear the sensor signal entry;

output files	diagnostics	sensor signals	pre-processing o	ontrol		
	in pre-processing "	2 G only if necessa	ary C unconditiona	llv		
	in pre-processing	i se only in necessa	ary so uncondicione			
append pr	e-processed data '	? C no 🖲 yes, if	available and data fi	le is not write	-protected	

Figure 37: cosin/tools for tires output specification menu

The **pre-processing control** sub-menu (shown in figure 37) defines the pre-processing behavior of the model during a **FTire** simulation call. The following options are available:

- run pre-processing, radio-buttons to define when the pre-processing calculations should be conducted. The following options are available:
 - only if necessary, to run the preprocessing only when the parameter file has changed or if the pre-processed data is not available (recommended);
 - unconditionally, to run the pre-processing for every solver call;
- append pre-processed data, radio-buttons to define whether or not the pre-processed data is allowed to be appended to the original data file. The following options are available:
 - no, to not write data to the original file;
 - yes, if available and data file is not write-protected, to appended the pre-processed data to the original file;

2.19 Version Control

The version control menu (shown in figure 38) lists settings that control the compatibility mode, library locations and road evaluation preferences. The menu is divided into four sub-menus. The sub-menus are:

- compatibility mode, radio-buttons to set the optional parameter (called compatibility date or previously feature date) that allows the user to specify a date such that all FTire model changes, being implemented after this date, will be deactivated. Full compatibility with older versions is comprehensively tested only from compatibility mode date 2015/07/01 on, due to major numerical optimizations in the core solver routines with version 2015-1. It is generally recommended not to use the compatibility mode unless there is a good reason to do so. The compatibility mode date is no "version string" related to the library version used, and it is not required to tag older input data if used with a more recent library version. Nor is the compatibility mode intended to fix model stability problems. On the contrary, in general, the most recent version is the best. If you will find a certain solver issue that seems to be cured in compatibility mode, please contact the product support hotline for an investigation of the problem. For all available compatibility dates, and corresponding model changes, please visit the FTire modelization and parameter specification documentation. The following options are available:
 - use all standard features (recommended);
 - use all standard + experimental features;
 - only use features introduced until the file generation date;
 - only use features introduced until today;
 - only use features introduced until..;
- cti library selection (only Adams), radio-buttons to specify the cosin tire interface library that should be used. The following options are available:
 - from cosin installation;
 - from Adams installation;
- user library location, to define the path to the directory holding optional user-defined libraries for rim and road models. The following options are available:
 - default, lib folder in the private directory;
 - specify, to specify a path to the library. The following button is available:
 - * X (clear button), to clear the entry field;
 - * ••• (browse button), to select the sound file from a file browser;
- road evaluation preference, to define the preferred road evaluation method. The following options are available:
 - default;
 - cosin;

- cosin (no 3rd-party calibration);
- 3rd-party road evaluation methods;

C Version control: _default.tir (autosave)				
File Output Help				
compatibility mode				
always use all available features (recommended)				
C only use features introduced until file generation date	2013-09-2	20		
C even in future, only use features introduced until today	y: 2018-1	0-11		
C create same results as with cosin version ?				
C only use features introduced until ?				
use library C unconditionally from cosin installation	€ as s	et in Adams envi	ironment	
user library location				
user library path ? C default G specify:		n/a		×
road evaluation preference				
prefer 🗭 default C cosin C cosin (no 3rd-party cali	ibration)	C 3rd-party	road evalua	ation method
	ok	cancel		apply

Figure 38: cosin/tools for tires version control menu

2.20 Open in Text Editor

Selecting the 'open in text editor' button will open the current tire data file in a text editor.

2.21 Polish Data File

Selecting the 'polish data file' button will clean the data file, and remove all unused parameters.

2.22 Discard Pre-Processed Data

Selecting the 'discard pre-processed data' will remove the pre-processed data from the tire data file.

3 cosin/tools for tires's Data Analyzes Menu (analyze)

In the data analyzes menu - **analyze** (shown in figure 39) all relevant tire data file analyzes tools are grouped into a few manageable menus. The menu consists of the following sub-menus:

- Fingerprint;
- General Properties;
- Cross Section;
- Mass correction data;
- Local Belt Stiffness;
- Pressure Dependencies;

- Visualize Structural DOF's;
- Vary Design Parameters;
- Compare With;
- Configurable Fingerprint;
- Static Analysis;
- Steady-State Analysis;
- Interactive Analysis;
- Linearization;
- Modal Analysis;

default.tir i j i pp rt2 model type FTire acces acces treat last access 2018/10/01 16:01:33 treat treat compat. data 2099/12/31 treat air v brand n/a air v freat size 205/55 R 16 91V 6.5J cont freat inflation pressure 2.40 bar rpm stat edit analyze process post-process th fingerprint general properties cross section cont cont mass correction data local heit titffness fingerprint fingerprint	cosin scientifi pattern hal model wear pration im ct elements with mass all contact sensor ally balanced	c softwa	are
model type FTire acces last access 2018/10/01 16:01:33 treat treat 2099/12/31 treat manufacturer n/a air brand n/a file size 205/55 R 16 91V 6.5J cont inflation pressure 2.40 bar stat edit analyze process post-process fingerprint general properties cos cross section cos scotion mass correction data fist	erated execution pattern hal model wear Dration im nct elements with mass all contact sensor ally balanced		
edit analyze process post-process h fingerprint general properties cross section mass correction data local helt stiffness	elpers		
fingerprint general properties cross section mass correction data local helt stiffness			
general properties cross section co mass correction data sta local belt stiffness			
cross section co mass correction data local belt stiffness			
mass correction data sta			
local belt stiffness	figurable fingerprint		
local belt sufficient	ic analysis		
pressure dependencies ste	idy-state analysis		
visualize structural DOFs	ractive analysis		
lin	arization		
vary design parameters	dal analysis		
compare with			
show diffs with > 200 %			

Figure 39: cosin/tools for tires analyze main menu

3.1 Fingerprint

The **FTire** fingerprint report comprises of a set of standard simulation results that can be used to analyze and compare the tire behavior without sharing the tire parameters. This report can further be used to identify a tire data file. The results presented in the report comprise of footprints, static and steady sate tests, as well as dynamic cleat test simulation results. The computation time, to generate the report, is a few minutes(approximately 5-15 minutes depending on the computer hardware used). The report can be requested by selecting the 'fingerprint' button, in the 'analyze' tab, or by selecting the **@** (fingerprint button) in the cosin/tools for tires's Main Menu. The following options are available:

• left clicking the buttons, to compute and show the fingerprint report;

• right clicking the buttons, to compute, shown and save the fingerprint report to a user specified location;

3.2 General Properties

The 'general properties' button can be used to determine a set of key FTire model properties. The computation time, to compute the key model properties, is a few seconds(approximately 20-60 seconds depending on the computer hardware used). The results will be shown in a cosin Message window. Buttons are available to edit, save or print the model properties.

3.3 Cross Section

Selecting the 'cross section' button, or the **(loupe** button) in the cosin/tools for tires's Main Menu menu, will display a graphical representation of the model's cross section (see figure 4). The sidewall contour line is shown in blue color, the tread surface shown in red color, and the contact element's position, direction, and length, also shown with red lines. The theoretical rim and tire main dimensions, as derived from the tire/rim size string, are indicated the yellow area. The maximum tire radius, and width, is also shown in the figure.

If the 'cross section' button is selected with the right mouse button, then the cross-section node numbers will be shown on the cross section.

3.4 Mass correction data

The 'mass correction data' button can be used to determine the FTire mass and inertia correction data that needs to be accounted for in a multi-body-system (MBS) model. FTire discretizes the mass and inertia properties of tire into two bodies, tire_free and tire_fixed. The tire_free mass is spread over the belt nodes, and is accounted for by FTire, while the fire_fixed mass is fixed to the rim and needs to be accounted for in the MBS model. The difference between total tire mass and free tire mass, together with the respective axial and radial moments of inertia, are to be added to the rim part in the calling MBS model. The FTire mass correction data output is shown in figure 40. Buttons are available to edit, save or print the mass correction data.



Figure 40: cosin/tools for tires FTire mass correction data

A visual representation of the two modeling approaches is shown in figure 41.

Modeld in MBS	Action to be taken	Result
MBS wheel assembly: rim only	Add tire_fixed mass and inertia components to the rim body. Tire_free mass and inertia is accounted for by FTire.	
MBS wheel assembly: one/two	Subtract tire_free mass and inertia components from the tire body. Tire_free mass and inertia is accounted for by FTire.	A COLOR
bodies, tire and rim		
Tire_free body (accou	unted for by FTire)	
Tire_fixed body (acco	unted for in MBS wheel assembly model)	
Rim body (accounted	for in MBS wheel assembly model)	

Figure 41: FTire mass correction visualization

3.5 Local Belt Stiffness

The button 'local belt stiffness' will display the normalized static load-deflection characteristic of a belt element (figure 42, not to be confused with the tire's global load-deflection curve). This characteristic is shown merely for plausibility checks. The slopes, of the local radial, lateral and longitudinal belt stiffness, should neither become too progressive, nor too degressive. Most of all, the slope should remain positive.



Figure 42: cosin/tools for tires local belt stiffness plausibility visualization

3.6 Pressure Dependencies

The '**pressure dependencies**' button can be used to determine the tire model dependencies on the tire inflation pressure. Among others the pressure dependency on the rolling circumference, tire stiffness and damping behavior as well as frequency response is determined. The computation time is a few minutes(approximately 1-5 minutes depending on the computer hardware used). For further analyses the results are opened in **cosin/ip**.

3.7 Visualize Structural DOF's

The 'visualize structural DOF's' button can be used to visualize the degrees of freedom of a single **FTire** belt segment. The animations are opened in a **cosin Graphics** window. Figure 3.7 shows two screen grabs of the first belt segments third and sixth structural degree of freedom animation.



Figure 43: cosin/tools for tires structural DOFs visualization

3.8 Vary Design Parameters

The 'vary design parameters..' menu button can be used to set up-to four design parameters. These parameters can be used for tire parameter sensitivity studies. The design parameters can be used as a place holders of a parameters (eg tread_depth=p1) or as scaling factors (eg tread_depth=8*p1) in the tire data file.

3.9 Compare With

The 'compare with..' button can be used to run a FTire data file comparison. The currently open tyre data file will be compared to a user defined tire data file to determine a list of parameters that differ between the two files. The list, containing all differing parameters, their values and percentual deviation, will be shown in a FTire Data Comparison window (figure 44). Buttons are available to edit, save or print the parameter list.

The Outrant Links							
<pre>(1) _default.tir in C:/Users/User/cosin (2) pass_car_205_55R16_91V. in C:/Users/User/cosin</pre>	private/ftire tir private/ftire	/param					/
differences in FTire model	data						I
differing parameters	unit	(1)	(2)	deviation			
rolling_circumference	mm	1916.91	1916.06	-0.04 %			
belt_width	mm	178.72	165.822	-7.22 %			
tread_width	mm	178	160.402	-9.89 %			
f1	Hz	54.0751	n/a				
f2	Hz	69.7207	n/a				
£4	Hz	50.3253	n/a				
f5	Hz	94.6744	n/a				
£6	Hz	88.1483	n/a				
D1	-	0.0901889	0.0562843	-37.59 %			
D2	-	0.0513958	0.0321725	-37.40 %			
D4	-	0.0694989	0.0594989	-14.39 %			•
	co	ollapse edit	save	print	clear	auit	ł.

Figure 44: cosin/tools for tires FTire Data Comparison window

3.10 Configurable Fingerprint

The '**configurable fingerprint**..' menu button can be used to define a set of operating conditions that should be used during the fingerprint simulations. The following options are available:

- operating conditions, to change the following operating conditions:
 - inflation pressure;
 - filling gas temperature;
 - mean tread surface temperature;
 - tread depth;
 - FTire speed mode;
- parameter variation ranges, to define the variation ranges of the following parameters:
 - max camber angle and # variations;
 - max load percentage relative to LI load and # variations;

- max speed and # variations;
- **component selection**, to define the report sections that should be included in the fingerprint report. The following components can be selected:
 - all, to create an complete fingerprint report;
 - properties, to only compute and report the model properties;
 - footprints, to only compute and report the footprint results;
 - static, to only compute and report the static results;
 - steady-state, to only compute and report the steady-state results;
 - cleats, to only compute and report the dynamic cleat simulation results;

C cosin/tools for Tires: Configurable Fingerpri	nt				×
File Output Help					
operating conditions					
inflation pressure	2.40	bar	(nominal 2.40	bar)	
filling gas temperature	20	deg C	(nominal 20 de	g C)	
mean tread surface temperature	20	deg C	(nominal 20 de	g C)	
tread depth	8.00	mm	(nominal 8.00	mm)	
FTire speed mode	0				
parameter variation ranges					
max camber angle	6	deg	# variations	3	
max load percentage relative to LI load	100	%	# variations	4	
max speed	90	km/h	# variations	3	
report content selection	prints C s	static	C steady-stat	e C	cleats
	c	ancel	save	ap	oply

Figure 45: cosin/tools for tires configurable fingerprint window

3.11 Static Analysis

The '**static analysis.**.' menu (shown in figure 46) can be used to define and run a static tire analysis. The following options are available:

- operating conditions, to define the following tyre operating conditions:
 - inflation pressure;
 - filling gas temperature;
 - mean tread surface temperature;
 - tread depth;
 - use tread pattern if available;
 - sticky surface;
 - tire rolling condition radio buttons:
 - * stand-still;
 - * slowly rolling;

- load/deflection, to define the loading condition with the following radio buttons:
 - deflection, to apply a vertical wheel displacement;
 - * additional entry fields are available to define the lateral and longitudinal wheel displacements as well as the camber, wheel rotation, and toe angle of the tire;
 - wheel load, to apply a vertical wheel load;
 - * additional entry fields are available to define the lateral and longitudinal wheel displacements as well as the camber, wheel rotation, and toe angle of the tire;
 - LI load prec., to define the vertical loading condition by the load index percentage;
 - * additional entry fields are available to define the lateral and longitudinal wheel displacements as well as the camber, wheel rotation, and toe angle of the tire;
 - forces & moments, to define the loading condition by specifying the:
 - * longitudinal force;
 - * lateral force;
 - * wheel load;
 - * aligning torque;
- surface geometry, to define the road surface conditions for the analyses with the following inputs:
 - surface type:
 - * flat;
 - * transv. cleat;
 - * long. cleat;
 - * 45deg cleat;
 - * block;
 - cleat/block width;
 - cleat bevel edge width;
 - longitudinal obstacle shift;
 - lateral obstacle shift;
 - longitudinal obstacle move;
 - lateral obstacle move;
- alternative road data file, to define a road road data file. The following buttons are available:
 - X (clear button), to clear the entry field;
 - *** (browse button), to select the road data file from a file browser;
 - (loupe button), to view the road data file with cosin/tools for roads;
 - 🖉 (edit button), to edit the road data file in an ascii editor;

- external forces/moments, to define externally applied forces and moments. The following forces/moments can be defined:
 - external radial force;
 - external lateral force;
 - external twist torque;
- **output**, check-box to activate the visualization output . If the check-box is selected then the static simulation results will be shown in a **cosin Animation** window.

Three buttons are available on the bottom right corner of the Static Analysis window:

- cancel, to close the cosin/tools for tires: Static Analysis window;
- loop.., to run the static analysis for multiple conditions. This option is discussed below;
- apply, to run the static analysis;

C cosin/tools for Tires: Static Analysis			×
File Output Help			
operating conditions			
inflation pressure	2.40	bar (nominal 2	40 bar)
filling gas temperature	20	deg C (nominal 2	0 deg C)
mean tread surface temperature	20	deg C (nominal 2	0 deg C)
tread depth	8.00	mm (nominal 8	.00 mm)
use tread pattern if available	Г		
sticky surface	v		
← stand-still ← slow	ty rolling		
load / deflection			
input: C deflection C wheel load	C LI loa	ad perc. C forces	& moments
perc. of LI load	80	%	
longitudinal displacement	0	mm	
lateral displacement	0	mm	
camber angle	0	deg	
wheel rotation angle	0	deg	
toe angle	0	deg	
surface geometry	C long cl	est C 45 deg cles	t C Nock
cleat /block width	20	mm	L & DIOCK
cleat hevel edge width	0		
	0	mm	
lateral obstacle shift	0	mm	
loneitudinal obstacle move	0	mm	
lateral obstacle move	0	mm	
alternative road data file			×🔍 🥒
external forces / moments			
external radial force	0	N	
external lateral force	0	N	
external twist torque	0	NM	
output			
visualize	Г		
		nool loos	apply
	ca	ιοορ	apply

Figure 46: cosin/tools for tires static analysis menu

The Multiple Parallel Simulation Loop window, is shown in figure 47. The menu can be used to define up to two nested parameter and/or operating condition variations for which simulations should be conducted. The following options are available:

- vary operating conditions, equally spaced, check-boxes to activate the variation of various operating conditions. Entry fields are available to define the starting, step end values;
- vary predefined design parameters, equally spaced, check-boxes to activate the variation of various predefined design parameters. Entry fields are available to define the starting, step end values;
- vary user-defined parameters, equally spaced, check-boxes to activate the variation of various user-defined parameters. Entry fields are available to define the parameter names, starting, step end values;
- vary user-defined parameters, generally spaced, check-boxes to activate the variation of various user-defined parameters. Entry fields are available to define the parameter names and comma-separated parameter values;

To use this function, replace any numeric simulation input value, that is listed in the analysis menu (eg. figure 46), or FTire model parameter with a predefined parameter name (eg. p1/p2/p3/p4). The user-defined parameters may only be used to replace the simulation input values. Three buttons are available in the the Multiple Parallel Simulation Loop window:

- (loupe button), to show the selected parameter variations and corresponding case numbers;
- ok, to create and run the variation cases. After the simulation the window will be closed;
- cancel, to close the Multiple Parallel Simulation Loop window;
- apply, to create and run the variation cases;

C Multiple	Parallel Simu	lation Loop					×
File Outpu	ıt Help						
Define on	e or two nest	ed parameter va	riations				
select (one or two art	itrary simulation	and/or mo	del parameto	er(s)		
Vary oper	ating conditio	ons, equally spac	ed:				
🗖 vary	inflation pre	ssure from	0.5	step	0.5	to	4.0
☐ vary	tread dept	h from	1	step	1	to	8
and/or var	v predefined	design paramete	ars equal	lly spaced:			
	y predenned	r design paramete	ers, equa	ily spaced.			
🔽 vary	p1	from	0.5	step	0.1	to	1.5
E varv	n2	from	0.5	sten	0.1	to	1.5
,,	22		0.5	stop			
🔲 vary	p3	from	0.5	step	0.1	to	1.5
⊂ varv	p4	from	0.5	step	0.1	to	1.5
and/or var	v user-define	ad parameters e	qually spa	aced:			
	y user-define	o parameters, es	quany spe	aceu.			
🔽 vary	v	from	20	step	10	to	120
□ vary	Fz	from	3	step	3	to	9
and/or var	v urer-define	d parameters a	aparally	inaced:			
	y user-define	eu parameters, ge	enerally s	spaceu.			
🔲 vary	v	comma-separa	ted values		20,4	0,100	
C varv	Fz	comma-separat	ted values		3.6	.10	
,,							
0				ok	can	cel	apply
-							

Figure 47: cosin/tools for tires analysis loop menu

3.12 Steady-State Analysis

The '**steady-state analysis**..' menu (shown in figure 48) can be used to define and run a steady-state tire analysis. The following options are available:

- operating conditions, to define the following tyre operating conditions:
 - inflation pressure;
 - filling gas temperature;
 - mean tread surface temperature;
 - tread depth;
 - rolling speed;
 - turning speed;
 - drum diameter;
 - friction modification factor;
- **load/deflection**, radio-buttons to define the vertical loading condition with the following radio buttons:
 - deflection, to apply a vertical wheel displacement;
 - wheel load, to apply a vertical wheel load;
 - LI load prec., to define the vertical loading condition by the load index percentage;
- horizontal control, radio buttons to define the horizontal loading condition with the following options:
 - wheel slip, to define a wheel slip percentage;
 - * additional entry fields are available to define the slip and camber angle of the tire;
 - drive torque, to apply a drive/braking torque;
 - * additional entry fields are available to define the slip and camber angle of the tire;
- simulation details, to define additional simulation and animation settings. The following options are available:
 - simulation time, to define the simulation duration;
 - surface distortion amplification, to define the tire surface distortion amplification factor that should be used for the animation;
 - switch off model extensions, check-box to disable all active model extensions (eg side wall contact model, thermal model, etc.);
- additional output, to define additional output parameters. The following options are available:
 - visualize, to output the simulation animation;
 - don't compute additional dynamic properties, radio-button to disable the computation of additional dynamic tire properties;

- compute damping (blocked wheel), radio-buttons to enable the computation of additional damping tire properties with a blocked wheel. The following options are available:
 - * long., to compute the longitudinal damping value;
 - additional entry fields are available to define the deflection amplitude and frequency to be used for the damping calculation;
 - * lat., to compute the lateral damping value;
 - additional entry fields are available to define the deflection amplitude and frequency to be used for the damping calculation;
 - * radial, to compute the radial damping value;
 - additional entry fields are available to define the deflection amplitude and frequency to be used for the damping calculation;
- compute relaxation length, radio-buttons to enable the computation of tyre relaxation length. The following options are available:
 - * Fx, to compute the fore-aft force relaxation length;
 - an additional entry field is available to define the wheel slip step size, to be used for the relaxation length calculation;
 - * Fy, to compute the side force relaxation length;
 - an additional entry field is available to define the slip angle step size, to be used for the relaxation length calculation;
 - * Mz, to compute the aligning torque relaxation length;
 - an additional entry field is available to define the slip angle step size, to be used for the relaxation length calculation;
- compute dynamic rolling radius, check-box to compute the dynamic rolling radius;
- validate footprint, check-box to compare the simulation footprint result to a footprint measurement. If selected the following information is required:
 - * measured footprint img file (in), to define the measurement input file. The following buttons are available:
 - ••• (browse button), to select the footprint image file from a file browser;
 - · 🔍 (loupe button), to view the footprint image file;
 - * footprint comparison img file (out), to define the comparison output file. The following buttons are available:
 - ••• (browse button), to select the footprint image output file from a file browser;
 - • (loupe button), to view the footprint image file;
 - * footprint bitmap scaling factor, to define the image scaling factor;

* **footprint bitmap rotation**, to define a image rotation angle to align the measured footprint with the simulation output.

Three buttons are available on the bottom right corner of the cosin/tools for tires: Steady-State Analysis window:

- cancel, to close the cosin/tools for tires: Steady-State Analysis window;
- loop.., to run the steady-state analysis for multiple conditions. This option is discussed in section 3.11;
- apply, to run the steady-state analysis;

C cosin/tools for Tires: Steady-State Analysis		×
File Output Help		
operating conditions		
inflation pressure	2.40	bar (nominal 2.40 bar)
filling gas temperature	20	deg C (nominal 20 deg C)
mean tread surface temperature	20	deg C (nominal 20 deg C)
tread depth	8.00	mm (nominal 8.00 mm)
rolling speed	50	km/h
turning speed	0	turns/s
drum diameter (flat if void)		m
friction modification factor (none if void)		
load / deflection	diand G i	Liesd percentage
input: C detection C whe	er toau 👎 1	or
perc. or Litioau	80	2
horizontal control		
input: ፍ wheel slip C	drive torqu	Je
wheel slip (braking: <0)	0	%
slip angle	0	deg
camber angle	0	deg
-local-blass state lla		
simulation details	0.5	
	1.0	
surface distortion ampuncation	-	
switch on model extensions		
additional output		
visualize	v	
don't compute additional dynamic properties	e	
compute damping (blocked wheel):	C long. C	🗋 lat. 🧲 radial
for damping, use: defl. ampl.	5 mm	freq. 3 Hz
compute relaxation length:	C Fx C	Fy C Mz
for relaxation length, use: wheel slip step	3 %	slip angle step 3 deg
compute dynamic rolling radius	Г	validate footprint
	_	
	can	cel loop apply

Figure 48: cosin/tools for tires steady-state analysis menu

3.13 Interactive Analysis

The 'interactive analysis..' menu (shown in figure 49) can be used to define and run a user interactive tire analysis. The following options are available:

- interactive simulation details, to define the following simulation operating conditions:
 - rolling condition, radio-buttons to define the tire rolling condition. The following options are available:
 - * control wheel slip, to control the wheel slip during the interactive simulation;

- * free rolling, to run a free rolling interactive tire analysis;
- drum diameter (flat if void), to define the road curvature during the analysis;
- friction modification factor (none if void), to define a road -tire friction modification factor;
- # cross-section modifiers, to define the number of control sliders that can be used to vary the local belt radius during the interactive analysis. The cross-section modifiers will be equally spaced across the belt width;
- animation settings, to define the simulation animation settings. The following options are available:
 - tire structure, radio-buttons to define the rendering of the tire structure. The following render settings are available:
 - * rendered;
 - * wire frame;
 - colorized, to define the tire structure surface color dependencies (if the rendered option is selected). The following options are available:
 - * temperature;
 - * wear;
 - * distortion;
 - * air pressure distribution;
 - * air flow distribution;

Two buttons are available on the bottom right corner of the cosin/tools for tires: Interactive Analysis window:

- cancel, to close the cosin/tools for tires: Interactive Analysis window;
- apply, to run the interactive analysis;

C cosin/tools for Tires: Interactive Analysis			×
File Output Help			
interactive simulation details			
	€ control	ed wheel slip C free rolling	
drum diameter (flat if void)		m	
friction modification factor (none if void)			
# cross-section modifiers	6	none if left blank	
animation settings			
tire structure:	C rendere	d 💽 wire frame	
colorized:	C tempera	ture C wear C distortion	
	C air pres	sure distribution C air flow dist	ribution
		cancel a	pply

Figure 49: cosin/tools for tires interactive analysis menu

3.14 Linearization

The 'linearization..' menu (shown in figure 50) can be used to define and run a non-linear system linearization. The following options are available:

- operating conditions, to define the following operating conditions:
 - inflation pressure;
 - filling gas temperature;
 - mean tread surface temperature;
 - tread depth;
 - rolling speed, for numerical reasons any rolling speed below 10km/h will be treated as a non-rolling case;
 - glue footprint to ground, if not rolling (check-box);
- load/deflection, to define the vertical loading condition with:
 - vertical deflection;
- horizontal motion, radio buttons to define the horizontal motion loading condition with the following options:
 - wheel slip, to define a wheel slip percentage;
 - * additional entry fields are available to define the slip and camber angle of the tire;
 - drive torque, to apply a drive/braking torque;
 - * additional entry fields are available to define the slip and camber angle of the tire;
- horizontal displacement, radio buttons to define the horizontal displacement loading condition with the following entry fields:
 - longitudinal displacement;
 - lateral displacement;
 - rotation about vertical axis;
 - rim rotation angle
- surface geometry, to define the road surface conditions for the analyses with the following options:
 - flat;
 - transv. cleat;
 - long. cleat;
 - 45deg cleat;
 - block;
- linearization details, to define the linearization details with the following entries:
 - **frequency**, to define the upper frequency limit;

- modal damping, to define the upper damping limit;
- mode selection gain tolerance;
- linearized system order;
- M-file output, to define the Matlab compatible output file names. The following options are available:
 - save time-discrete A,B,C,D, to define the output file name and location. The following button is available:
 - * ••• (browse button), to select the output file save location from a file browser;
 - save time-discrete A,B,C,D, to define the output file name and location. The following button is available:
 - * ••• (browse button), to select the output file save location from a file browser;
 - matrix name suffix, to define the matrix suffix that should be used in the output files;

Two buttons are available on the bottom right corner of the cosin/tools for tires: Linearization window:

- cancel, to close the cosin/tools for tires: Linearization window;
- apply, to run the linearization;

C cosin/tools for Tires: Linearization						×
File Output Help						
operating conditions						
inflation pr	ressure	2.40	bar	(nominal 2.4	10 bar)	
filling gas tempe	erature	20	deg C	(nominal 20	deg C)	
mean tread surface tempe	erature	20	deg C	(nominal 20	deg C)	
tread	d depth	8.00	mm	(nominal 8.0	0 mm)	
rolling	speed	0	km/h			
	Г	glue foo	tprint t	o ground, if	not rolling	
load / deflection		20				
vertical der	tection	20	mm			
horizontal motion						
input: @ wheel	slip C dr	ive torqu	e			
wh	eel slip	0	%			
sti	p angle	0	deg			
cambe	r angle	0	deg			
horizontal displacement	t	0				
longituumat uisplat	cement	0				
rotation about vartic	cal avic	0	dea			
rim rotation		0	deg			
Thirtotatio	in ungic		UCB			
surface geometry						
flat C transv.	cleat C	long. clea	t C 4	15 deg cleat	C block	
linearization details						
frequenc	v up to	300	Hz			
modal dampin	g up to	100	%			
mode selection gain to	erance	1000				
linearized system	n order	50				
M-file output						
save time-discrete A,B,C,D: C:/Users	/User/cosi	n private	/matlab	/ftire_abcd_	discr.m	
save time-cont. A,B,C,D: C:/Us	ers/User/c	osin priva	ate/mat	llab/ftire_ab	cd.m	
matrix name	suffix:	FTire				
				cancel	apply	
				cancer	upply	

Figure 50: cosin/tools for tires linearization menu

3.15 Modal Analysis

The '**modal analysis.**.' menu (shown in figure 51) can be used to define and run a modal analysis. The following options are available:

- modal analysis in, to define the modal analysis loading conditions:
 - unloaded, to conduct a modal analysis on an unloaded tire. The following information is required:
 - * order up to, to define the upper order limit;
 - * frequency up to, to define the upper frequency limit;
 - loaded, to conduct a modal analysis on a laden tire. The following information is required:
 - * order up to, to define the upper order limit;
 - * frequency up to, to define the upper frequency limit;
 - * modal damping up to, to define the upper damping limit;
- operating conditions, to define the following operating conditions:

- inflation pressure;
- filling gas temperature;
- mean tread surface temperature;
- tread depth, (only available for loaded condition);
- rolling speed, (only available for loaded condition) for numerical reasons any rolling speed below 10km/h will be treated as a non-rolling case;
- glue footprint to ground, if not rolling (check-box, only available for loaded condition);
- load/deflection, (only available for loaded condition) to define the vertical loading condition with:
 - vertical deflection;
- horizontal motion, (only available for loaded condition) radio buttons to define the horizontal motion loading condition with the following options:
 - wheel slip, to define a wheel slip percentage;
 - * additional entry fields are available to define the slip and camber angle of the tire;
 - drive torque, to apply a drive/braking torque;
 - * additional entry fields are available to define the slip and camber angle of the tire;
- horizontal displacement, (only available for loaded condition) radio buttons to define the horizontal displacement loading condition with the following entry fields:
 - longitudinal displacement;
 - lateral displacement;
 - rotation about vertical axis;
 - rim rotation angle
- surface geometry, (only available for loaded condition) to define the road surface conditions for the analyses with the following options:
 - flat;
 - transv. cleat;
 - long. cleat;
 - 45deg cleat;
 - block;

Two buttons are available on the bottom right corner of the cosin/tools for tires: Modal Analysis window:

- cancel, to close the cosin/tools for tires: Modal Analysis window;
- apply, to run the modal analysis;

C cosin/tools for Tires: Modal Analysis		:	< C cosin/	tools fo	r Tires: Moda	Analysis Resu	ilts				×
File Output Help			File Out	ut H	elp						
modal analysis in 📀 unloaded 🔿 loaded			results								
order up to	5			i	n-plane			OL	it-of-plane		
frequency up to	300	Hz	mode #	ord.	frequency	damping	mode #	ord.	frequency	damping	
			1	0	169.89 Hz	9.02 %	1	0	112.26 Hz	9.75 %	
operating conditions			2	1	221.69 Hz	5.14 %	2	1	165.12 Hz	6.95 %	
inflation pressure	2.40	bar (nominal 2.40 bar)	3	2	258.88 Hz	3.52 %	3	2	287.16 Hz	4.51 %	
filling gas temperature	20	deg C (nominal 20 deg C)	4	3	281.33 Hz	3.73 %					
mean tread surface temperature	20	deg C (nominal 20 deg C)									
		cancel apply		∏ cr	eate movie						

Figure 51: cosin/tools for tires modal analysis window, Left: menu; Right: results

The 'Modal Analysis Results' window (shown on the right-hand side of figure 51) can be used to view the modal analysis results. The results are sorted into in-plane and out-of-plane mode shapes. The following information is shown for all mode shapes:

- mode #, displaying the mode number of the in/out-of-plane mode. Selecting the mode number will open the mode shape animation in a cosin Graphics window. The following options and sliders are available:
 - mode shape amplification, slider to set the animation amplification factor;
 - animation speed, slider to control the animation speed;
 - render mode, left menu option to show the tyre surface as:
 - * rendered, keyboard shortcut 'r';
 - * meshed, keyboard shortcut 'm';
- ord, displaying the mode shape order;
- **frequency**, displaying the mode shape frequency;
- damping, displaying the damping value of the mode;
- create movie, check-box to create movie file of a mode shape animation.
 - save movie as.., button to save the movie file;

4 cosin/tools for tires's Data Processing Menu (process)

4.1 Repeat Pre-Processing

Button to force a repeat of the pre-processing.

4.2 Optimize Numerical Settings

Button to run a optimization of the numerical settings to improve and reduce the duration of the model pre-processing.

4.3 Reformat

The '**reformat'** menu (shown on the right-hand side of figure 52) can be used to export the FTire data file in a different format or with a preferred kind of tire properties. The following options are available:

- create this format, to define the export file format and unit system.
 - The following file formats are available:
 - * TeimOrbit .tir file (default);
 - * cosin/io .ft file;
 - The following unit systems are available:
 - * user-friendly (SI user-friendly);
 - * SI: mmks (millimeter/kilogram/second);
 - * SI: mks (meter/kilogram/second);
 - * USC (inch/pound/second);
- prefer this kind of tire properties when specifying data, to prefer the following kind of parameters (see Carcass / Belt Mass & Stiffness):
 - don't change;
 - direct (preferred);
 - static;
 - handling (standard);
 - handling (motorcycle);
 - static + handling (standard);
 - static + handling (motorcycle);
 - modal data;

Three buttons are available on the bottom right corner of the cosin/tools for tires: Export window:

- ok, to export the tire data file and to close the cosin/tools for tires: Export window;
- cancel, to close the cosin/tools for tires: Export window;
- apply, export the tire data file;



Figure 52: cosin/tools for tires reformat tire data file

4.4 Export To Pac2002 Model

The 'export to Pac2002 model' menu (shown in figure 53) can be used to create a Pac2002 model data file from the current FTire data file. The following options are available:

- job, to define the job that should be run. The following options are available:
 - automatically run through all steps;
 - * fast;
 - * accurate;
 - * full HTire model id.
 - * HTire w/o combined slip id.
 - only create virtual measurements;
 - only identify parameters;
 - only validate and create report;
- virtual measurement settings, to define the virtual test conditions that are used to create the virtual measurements. The following options are available:
 - min...max Fz, minimum and maximum load index percentage that should be used;
 - max. camber angle;
 - max. combined wheel slip;
 - max. combined slip angle;
 - single sweep duration;
 - sweep ranges:
 - * wheel slip;
 - * slip angle;

- Pac2002 parameter identification settings, the following options are available:
 - identify, radio-buttons to define what virtual measurements should be used to identify the Pac2002 model parameters. The following options are available:
 - * all;
 - * only Fx;
 - * only Fy;
 - * only Mz;
 - * only Fy + Mz;
 - * only combined slip;
 - * only combined slip for Fx;
 - * only combined slip for Fy;
 - * only combined slip for Mz;
 - number of data points to be used;
 - max. number of objective evaluations;
 - max parameter variation;
 - start with this Pac2002 data file, to define the initial Pac2002 data file. The following buttons are available:
 - * *** (browse button), to select the Pac2002 data file from a file browser;
 - * (loupe button), to open the Pac2002 data file with cosin/tools for tires;
 - * 🖉 (edit button), to edit the Pac2002 data file in an ascii editor;
 - create this Pac2002 data file, to define the name of the output Pac2002 data file. The following buttons are available:
 - * ••• (browse button), to select the Pac2002 data file location from a file browser;
 - * (loupe button), to open the Pac2002 data file with cosin/tools for tires;
 - * 🖉 (edit button), to edit the Pac2002 data file in an ascii editor;
- report, buttons to display and pack the report of the Pac2002 export. The following buttons are available:
 - **show report**, to open the created pdf export report(if available);
 - pack report, to pack the created pdf export report(if available) and tire data files into a folder;
 - show single Fx comp., to show a single longitudinal test comparison (if available);
 - show single Fy comp., to show a single lateral test comparison (if available);
 - show single Mz comp., to show a single aligning torque comparison (if available);

Two buttons are available on the bottom right corner of the cosin/tools for tires: create Pac2002 data file window:

- cancel, to close the cosin/tools for tires: create Pac2002 data file window;
- apply, export the Pac2002 tire data file;

C cosin/tools: create Pac200	2 data file					×
File Output Help						
iob						
automatically	run through all ste	ns C fast	G accurate	• full HTire model id	C HTire w/o combin	ed slin id
C aply graate y	intual manufacture	-	- accurace			
C unity create v	ir cuat measurement.	2				
only identify	parameters					
Only validate	and create report					
virtual measurement setting	s					
minm	ax Fz 25	150	% LI load			
max. camber	angle 4	deg				
max. combined whe	el slip 10	%				
max, combined slip	angle 10	deg				
single sweep dur	ration 10					
sween ranges: whe	vel din 15	S din angle	15 deg			
sheep rangest time	(C)(p) 15	20 Sub outpe	10 005			
Pac 2002 parameter identific	ation settings					
identify 🗭 all only: 🤇		z C Fy+Mz C	comb. slip C	comb. slip for Fx	comb. slip for Fy 🔘 c	omb. slip for Mz
number of data points to be	e used 10000	max. numbe	r of objective ev	aluations 50000		
max. parameter vari	iation 500	%				
start with this Pac2002 dat	ta file	C:/Users/	'User/cosin priva	te/ftire/param/sample	e_2002.tir	🔾 🥒
create this Pac2002 dat	ta file	C:/Users	/User/cosin priva	ate/report_ht/_best_	so_far.tir	Q
report						
show report	pack report	show	single Fx comp	show single Fy	comp. show sing	gle Mz comp.
					cancel	apply

Figure 53: cosin/tools for tires export Ftire data file to Pac2002 model

5 cosin/tools for tires's Results Post-Processing Menu (post-process)

5.1 Plot Results

The button '**plot results (mtl- or tdx -file)**' can be used to load, brows and plot measurement and/or simulation results in the interactive plot program - **cosin/ip**. The following file formats are supported:

- tdx, TDX;
- mtl, MTL;
- mtb, MTB;
- req, REQ;
- fft, FFT;
- csv, CSV;
- dwt, DWT;

5.2 Replay Record File

The button '**replay record file**' can be used to replay a recorded **FTire** simulation. The record file enables the analysis and exact 'replay' of the recorded **FTire** simulation without the calling vehicle model. The following file formats are supported:

• rec, REC;

5.3 Replay Animation

The button '**replay animation**' can be used to replay a recorded off-line **FTire** animation. The following file formats are supported:

• ogl;

5.4 Show Wheel Envelope

The button 'show wheel envelope (shl-file)' can be used to visualize the wheel envelope as saved during a previous FTire simulation. This button can also be used to visualize various CAD files (eg detailed rim CAD files, car body etc.). The following file formats are supported:

- str, STR;
- shl, SHL;
- stl, STL;
- obj, OBJ;

6 cosin/tools for tires's Data Helpers Menu (helpers)

The '**helpers'** menu (shown in figure 54) includes a units conversion tool as well as a calculator to evaluate any arbitrary arithmetic and/or function expression. The following unit conversions are available:

- millimeter < > inch (mm < > in);
- bar < > pound-force per square inch (bar < > psi);
- newton < > pound-force (N < > lbf);
- kilogram < > pound (kg < > lbs);
- kilometer per hour <> miles per hour (km/h <> mph);
- megapascal <> ShoreA hardness (MPa <> ShoreA);

C cosin/	'tools for	r Tires 20	18-4					_		×
File Edit	Outpu	ut Setti	ngs Hel	р						
_default	.tir 🔾	🖊 i @	рр г	t?		c	osir scien) tific	softv	vare
model last a last m comp manu branc size inflat	i type ccess wodificati at. date facturer l	FTir 2018 2099 n/a n/a 205/ ure 2.40	e 8/10/01 16 8/10/11 11 9/12/31 1/55 R 16 91 1/bar	5:01:33 1:46:16		accelerated e tread pattern thermal model tread wear air vibration flex rim contact eleme sidewall conta TP/NS sensor statically bala	nts with ct nced	mass		
edit	analy	ze p	process	post-pr	ocess	helpers				
unit c	onverter 1	r mm =	0.039	in						
	1	bar =	14.504	psi						
	1	N =	0.225	lbf	cal	culator				
	1	kg =	2.205	lbs					P	
	1	km/h =	0.621	mph						
	1	MPa =	32.278	ShoreA						

Figure 54: cosin/tools for tires helpers menu

7 cosin/tools for tires's Menu-bar Functions

The buttons in the menu bar of the cosin/tools for tires perform the following functions:

- File:
 - New tire creates a new tire data file with the use of some basic tire data;
 - Open tire .. opens a file explorer to open a tire data file;
 - Search tire in defines the location to search for a tire data file;
 - Open last open the last opened tire data file;
 - Open Recent open a tire data file from a selection of previously opened data files;
 - Save tire save current tire data file;
 - Save tire as .. save current tire data file with a new name;
 - Save tire in new format as .. save current tire data file in a new format (different file format, units and/or kind of tire properties);
 - Quit close cosin/tools for tires;
- Edit:
 - Diff with compares current data file to a previous data file;
 - Compare with lists all parameter changes between the current and previous data files;
 - Undo Undo recent parameter changes;
 - Undo all Undo all parameter changes;
- Output

- Hide/Show message window hide/show cosin message window;
- Show verbose msg window show the comprehensive log output in the cosin message window;
- Animation off/on Switch the animations on/off;
- Browse log file open the cosin Messages of the most recent application call;
- Browse auxiliary log file open the cosin Messages of the most recent auxiliary routine call;
- Save log file as.. save the cosin Messages of the most recent application call;
- Print log file print the cosin Messages of the most recent application call;
- Clear log file clear the cosin Messages of the most recent application call;
- List files of last run list all files that were created during the most recent application call;
- Settings
 - Preferences ..
 - * unit system specifies the unit system that is used in cosin/tools for tires. The following unit systems are available:
 - user-friendly (SI user-friendly);
 - SI: mmks (millimeter/kilogram/second);
 - · SI: mks (meter/kilogram/second);
 - **USC** (inch/pound/second);
 - save any data changes automatically set if data changes are automatically saved when modified in cosin/tools for tires;
- Help
 - cosin docu opens the cosin documentation, with links to all cosin documentation, user guides and copyright information;
 - FTire docu opens the FTire Modelization and Parameter specification documentation;
 - Support checklist opens the trouble-shooting guide, Support checklist, that should be checked before requesting technical support;
 - Load index table opens the load index (LI) table;
 - Speed index table opens the speed index table;
 - TYDEX axis system docu opens the TYDEX axis systems documentation;
 - TYDEX file format docu opens the TYDEX Description and Reference Manual;
 - About cosin/tools displays information about the installed cosin software version, revision and installation directory;
 - www.cosin.eu link to the cosin website