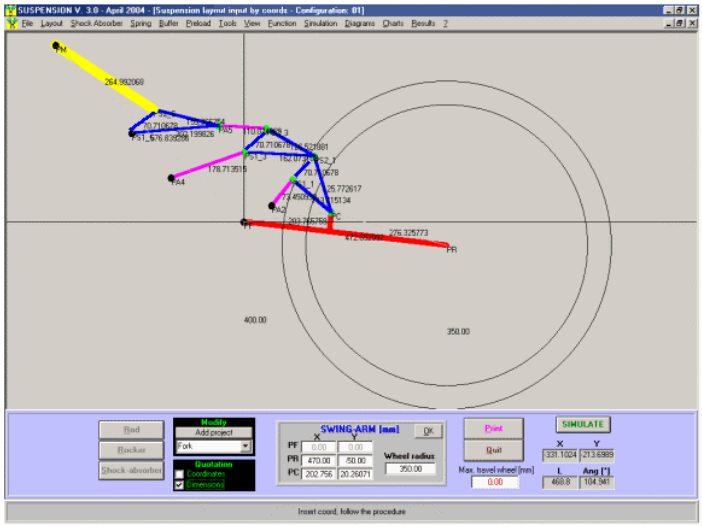
Soft-Engine - Software Suspension

Main features



A very complex suspension layout, planned by our software

SUSPENSION is a revolutionary **SOFT-ENGINE** software to allow project and testing of rear **motorcycle** and **bike** suspension systems for all possible layouts. Input data is extremely simple, because layout can be directly drown by user. So you can draw and test all possible rear motorcycle-bike layouts both the traditional ones and new design. Infact you can input untill 8 elements like rod, rockers: you can eventually ''invent'' new kind of suspension systems, as shown in the pictures! There is also the possibility to input geometrical data by dimensions and angles rather than coords. You have only to **draw the suspension geometry** and input free spring, dismounted shock absorber and (eventually) buffer data to create a complete **new project**, but, if you like, you can input and test each of these objects separately. After input data, you can test the behaviour of projected suspension by the simulation of drown layout (mouvement Vs Wheel travel) or study diagrams like **Progressive-rate of compression**, **Leverage ratio**, **Shock-absorber compression**, **Shock-absorber length**, **Wheel rate**, **Wheel load** and more others. For each quantity it's possible to watch the **peak value**,
to read the curve's instantaneous value step by step (''**Cursor**'' function), to compare new suspension project to analyse their differences and others.

SUSPENSION works in WINDOWS© environments (98, 2000, ME, XP).

Introduction

A rear motorcycle suspension is made by a swing-arm, a shock-absorber and a series of leverages that connect these two elements:
A SWING-ARM, is characterized by its lenght (in Suspension, it is the PF-PR distance) and by a PC point, in which the next leverages are connected;
RODS: it is a leverage, characterized by a length. Rod can be directly connected to motorcycle chassis by a fixed point (in suspension: point PA) or can connect two different leverages. In case there is a fixed point, its function is to control the mouvement of directed linked leverage, so it is also called "control link".
ROCKERS: they are not-deformable triangles, and their function is to link a suspension element with two others, or connect a suspension element with chassis (by a fixed point) and with another element.Rod can rotate or roto-translate, but it cannot change its form. The two triangle vertexes, PS1 and PS2, are the ones that connect the rocker with the two next elements.
SHOCK-ABSORBERS: In this software we distiguish two different situation:
1-the shock absorber is seen as a "static" suspension part: in this case, it is enough to give its lenghts and the coord of its chassis fixed point (PM); suspension can be studied from a static point of view;
2-the shock absorber is seen as a "Kinematic" suspension part: in this case software needs the lengths and fixed point coords, but also the spring elastic constant (or force), the internal parts's shock-absorber lengths, eventually the buffer or top-out data. By these data, software can study the projected suspension, by a kinematic point of view.
The shock-absorber length and PM coord data close the suspension draw procedure. The other "kinematics" shock-absorber data can be given to software in a second time.
And so:

- **To draw only rear suspension layout = static quantities computing**;
- **To draw rear suspension layout + shock-absorber's internal partsdata = static and kinematics quantities computing**

Obviously, Suspesion allows the British Sistem!

Suspension 3.0: description

1) REAR SUSPENSION LAYOUT DIRECT DRAW: as shown in the picture, **this software is new conception** and it is **very professional** because it allows any kind of rear motorcycle suspension system project, not standard too, but it is very easy to use because you **directly draw the suspension system:** you have to insert some definited **elements** like **SWING-ARM**, **RODS**, **ROCKERS**, **SHOCK-ABSORBERS, any order** , helped by software.

IT IS POSSIBLE TO DRAW INPUTING EACH VERTEX ITS X-Y COORDS. In this case it's possible to draw any kind of suspension, the complicated ones too, see the picture on the top of this page. It is possible to insert until 8 rod and rockers between swing-arm and shock absorber. Use this method to draw a suspension when you like to create a new kind of layout; in this case is convenient to give the orthogonal distances (= X, Y coords) from an origin point (in suspension the swing-arm fixed point PF), like in CAD programs, but Suspension input X-Y data is a more fast method , because this software's main purcase is to draw rear suspension layouts and to test them immediately.

After X.Y coords input, each suspension element lenght is automatically computed. It is possible to modify the X-Y coord until the correct lenght is reached. Infact there are several methods to modify data: firstly, the possibility to vary X-Y coords after layout design; there is also the possibility to regulate quickly the main suspension factors (like spring elastic constant, swing-arm lenght, top-out constant and top-rate etc..) or to create new layouts with very professional tools like "Reverse function" (version 4.0) and "Professional layout regulation" (also version 4.0).

IT IS POSSIBLE ALSO TO DRAW INPUTING EACH SUSPENSION ELEMENT LENGHTS. This method is convenient when user like to use this software to draw and analyse an exsistent suspension layout, and its the reference data appear as lengths. User must impose each element lengths, the X-Y fixed point only coords and a temporary angle of slope (simply, with a mouse click); then, at the end of design (=after shock-absorber corect data introduction) software will compute automathically the correct incliantoions.

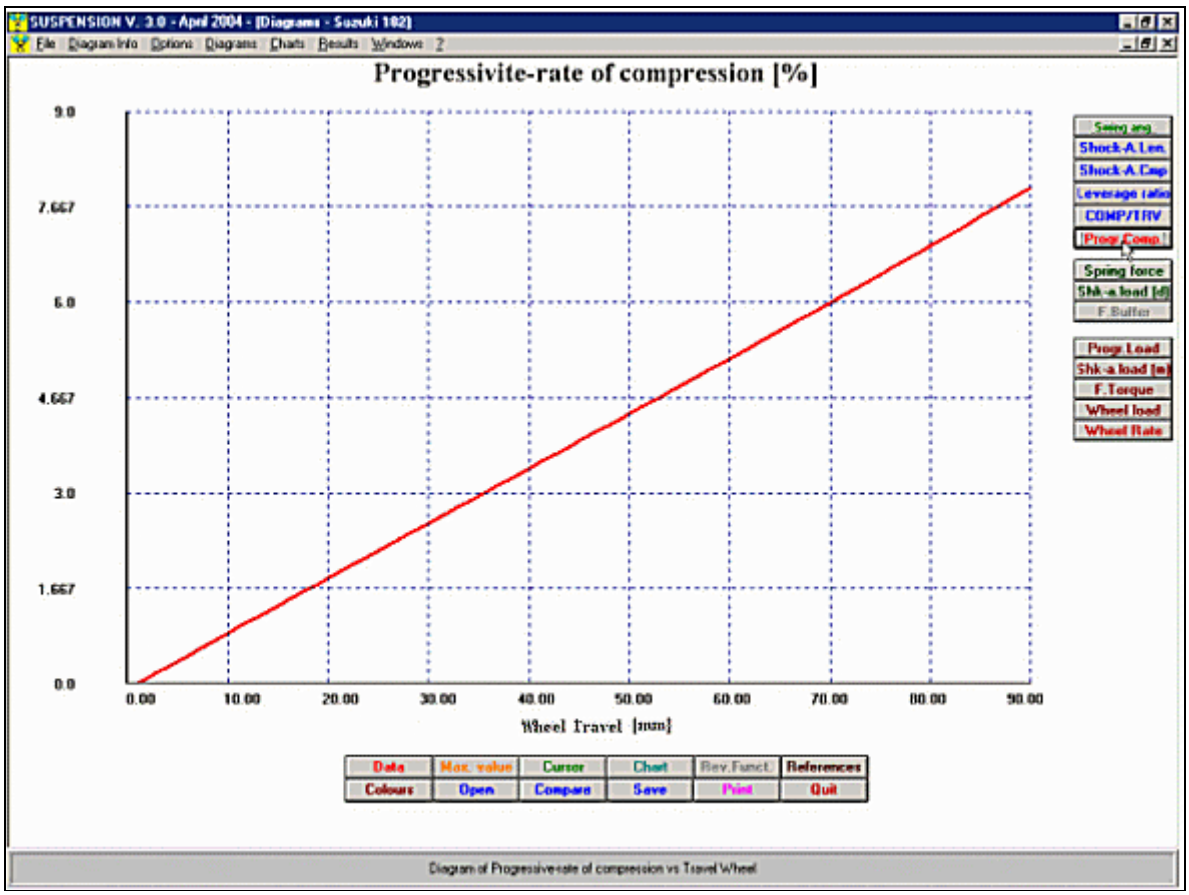
SOFTWARE PURPOUSE IS TO DESIGN SUSPENSION LAYOUTS, so data insertion is quick, simple and "visual". It is confortable to design quickly a suspension layout and immediately to watch diagrams, charts and to move the layout vs wheel travel. The layout drawing procedure is helped by software. Infact is impossible to draw layouts impossible from a geometrical point of view. Fixed and mobile points (black and green colour) are imposed by the software in a leverage during draw.

At design time there are also some tools that assist user, like:

- **Layout zoom, to see better some layout area;**
- **Pan: mouvement of layout vs origin point;**
- **References in X-Y coords or in dimensions;**
- **Animation of layout vs Wheel travel after design;**
- **Printing (zoomed also) of layput.**

2) KINEMATICS QUANTITIES DIAGRAMS AND CHARTS: after layout drawing the following kinematics quantities vs Wheel travel are immediately available:

- **Swing-arm angle**
- **Shock absorber length**
- **Spring compression Vs**
- **Spring compression / Wheel Travel**
- **Leverage ratio**
- **Progressive-rate of compression**



Diagrams: Progressive-rate of deformation

It is possible to watch and print diagram, charts of these quantities. You can also create or load untill six layouts and compare their diagrams and charts.

3) STATIC QUANTITIES DIAGRAMS AND CHARTS: Insert shock-absorber specific data in a second time after layout insertion to compute the forces. These data are:

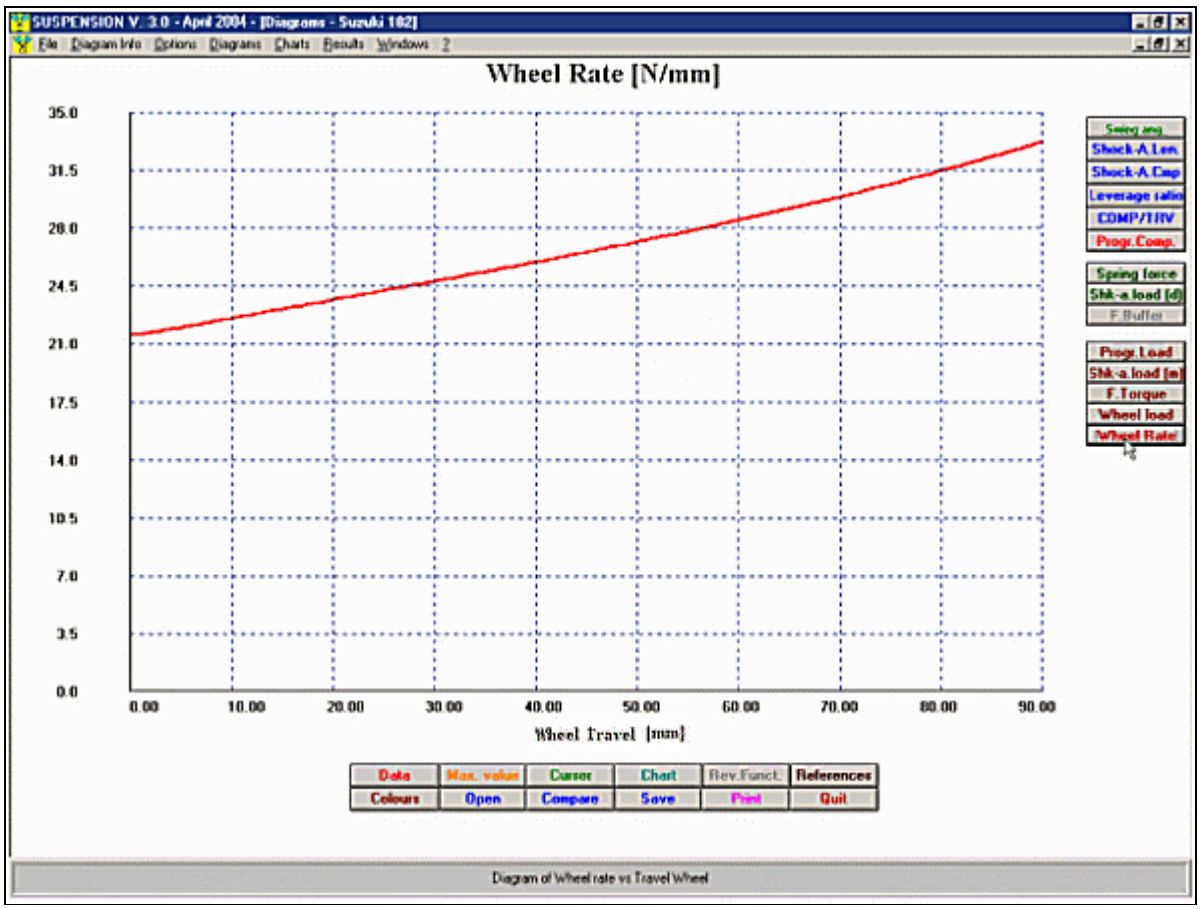
- **Shock-absorber** internal part dimensions, even gas pressure. Shock-absorber data input is compulsory to compute static quantities;
- **Spring** travel, elastic constant or force data. Spring data input is compulsory to compute static quantities;
- **Buffer** travel, elastic constant (or force) data. Buffer data input is optional;
- **Top-out** travel, elastic constant (or force) data. Top-out data input is optional;
- **Setup preload** data. Setup preload data input is optional.

The union of: **Layout** geometrical data, **Shock-absorber** specific internal data, **Spring** data and (optional) **Buffer**, **Top-out** and **Setup-preload** data create a **complete project**. Creating a complete project it is possible to watch diagrams and chart about:

- **Spring force Vs Spring stroke**
- **Dismounted shock-absorber load Vs Shock-absorber stroke**
- **Buffer force Vs Buffer stroke**

And the **static** computed quantities are (vs **wheel travel**):

- **Progressive rate of load**
- **Swing-arm torque**
- **Rear wheel load**
- **Wheel rate**



Diagrams: Wheel Rate

You can also create or load untill six projects and compare their diagrams and charts

4) RESULTS ANALYSIS BY DIAGRAMS, CHARTS AND REPORTS: SUSPENSION has a powerful method to analyse the results: infact there is a diagram page in wich is possible, for each quantity:

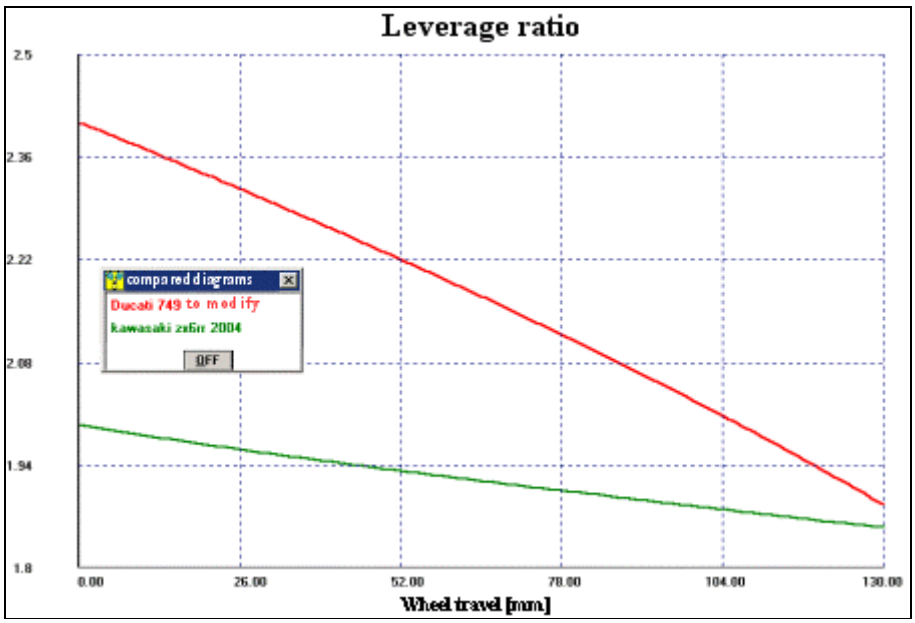
- **To read all diagrams data step by step, using thr "Diagram cursor" tool;**
- **To read the quantity peak value;**
- **To zoom the diagram;**
- **To have compared charts for each quantity.**

All several diagram functions are available from the only diagram window; in particular, is very simple to change the displayed quantity, because it is enough to click on the buttons on the right part of diagram window.
I the low part of diagram window there is a seriesof buttons to avail the main procedures: Change layout data, Peak value, Diagram cursor, (compared) chart of displayed quantity, Reverse function (4.0 version) Diagram reports, Colour management, File (Load, Compare, Save data) and printing.

And so:

- **All possible diagram options for analysis are available from diagram window;**
- **Diagram window colour management;**
- **X and Y axis scale management;**
- **Diagram and chart printings.**

It is particularly important, to analyse a layout behaviour, to have the possiblity to compare this one with others layouts quantities. And so:
COMPARING DIFFERRENT LAYOUTS OR PROJECT: It is possible to open or create until six different layout or projects, to compere their quantities. All analysis tools (charts, reports, diagram cursor, peak values, printings) are available for comparisons.



*Two different layouts comparison: **Ducati 749** e **Kawasaki ZX 6RR**.*
In this case the comparison is about "Leverage ratio" quantity, but comparison procedure is about each computed quantities

5) SEPARATE FILES: file management is quite simple because each part of suspension can be saved togheter in te project or separately. So it is possible to use this software for example to load three different shock-absorbers data for a suspension layout and watch the differences. Here the different file suspension can create:

- **Layout data;**
- **Shock-absorber data** (dimensions, gas pressure);
- **Shock-absorber spring data:** travel, elastic constant or force. It is possible to impose the same elastic constant value for all spring travel or to give a different value of elastic constant step by step. The same modality for spring force data input.
- **Buffer data:** the same of spring data.
- **Top-out input data:** the same of spring data.
- **Preload data:** total preload is automatically computed by software as the sum between Setup preload (imosed by user to simulate the real preload in a shock-absorber when some regulation are setted) and the mounting preload (computed by software, when a shock-absorber is imposed to a layout).
- **Complete project data**, the sum of layout, shock-absorber, spring, and, even, buffer, top-out and setup preload data.

6) LAYOUT VARIATION: "Suspension" has an important variation procedure. After layout drawing is possible to choose elements and vary its lenghts or coords (option "Modify"). If the button "Add to proyect" is clicked before the modify, a new layout is created to see the effect of modifications on quantities.

7) TOP-OUT: Software allow the top-out data input and computes the effect of top-out on some static quantities. The Top-out is a little spring with an high value of elastic constant, its mouvement is opposite of the mai shock-absorber spring one, so its presence is important for some static quantities. The point in which top-out starts is called "top-rate".

8) FAST LAYOUT SET-UP: This software function is right for whom like to use it quickly to modify some important suspension factord, like swing-arm length, elastic constant value, shock-absorber length, the top rate and many others, the software is able to show immediately the most important static and kinematics quantity variations for a specified wheel travel value and the diagrams It is possible to create a new layout with modifications to compare to the original one, so software show the suspension behaviour both before and after the modification.

9) IMPORT / EXPORT TEXT DATA FILE: This function is important to communicate with the main viedotyping

or data sheet software, like MS EXCEL. It is possible to save all charts in text format so other software can import "Suspension" data. On the contrary, it is possible to generate text data file using other software and import them into "Suspension". For example, it is possible to create a text file about any quantity (like "prograssive rate of compression") by Excel and import it into "Suspension" software to compare it with another layout. It is possible to import-eport also layout data as text format, but in this case it is necessary to fill a "form" that creates a "standard layout text file". Infact is impossible for the software to read any text file typology, it is necessary to respect some rules!

10) EXPORT LAYOUT AS DXF FILE: This option is important to save the layout in a DXF file format, in this case the layout can be opened by CAD software (for exaple AUTOCAD) .

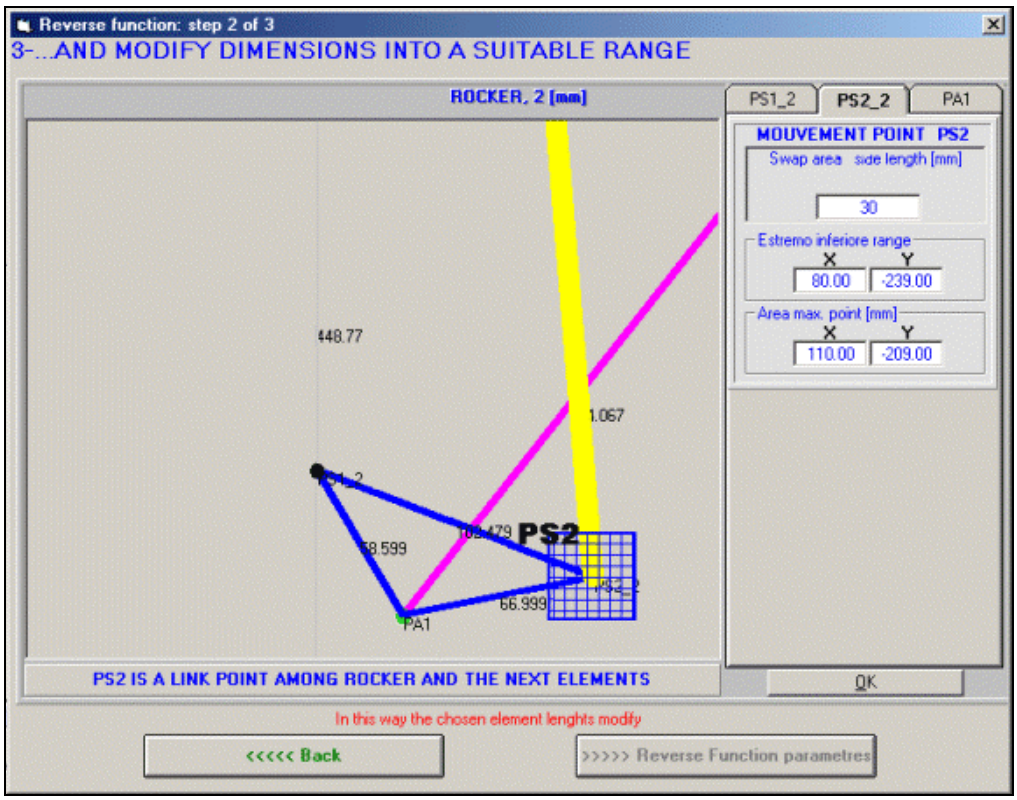
11) DOCUMENTATION / PAPERS: "SUSPENSION" is also an "educational" software: there is the possibility to receive by e.mail some SOFT-ENGINE suspension hi-tech documentation as PDF file. In this case, software has an added archive and it is possible to open PDF files directly by software. Send an **e.mail** to know which is the technical suspension documentation.

Suspension 4.0: description

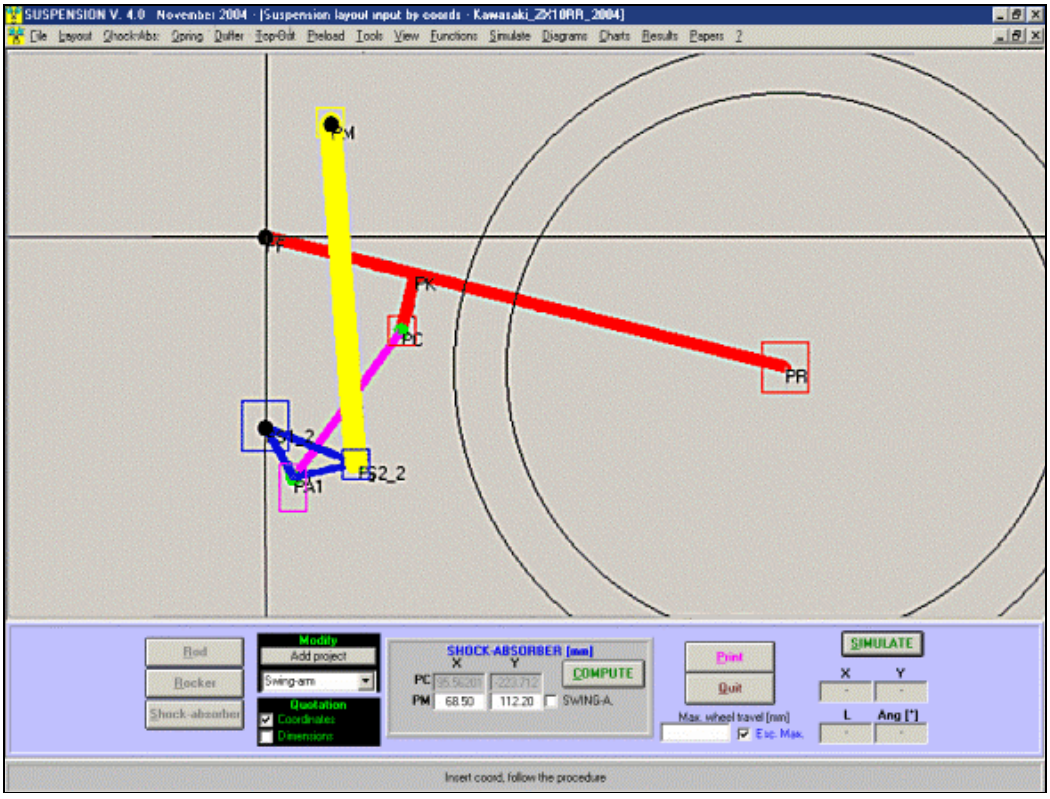
Suspension 4.0 has the same features of Suspension 3.0, but including:

1-REVERSE FUNCTION PROCEDURE;
2-THE "PROFESSIONAL LAUOUT SETUP" TO CREATE NEW LAYOUTS.

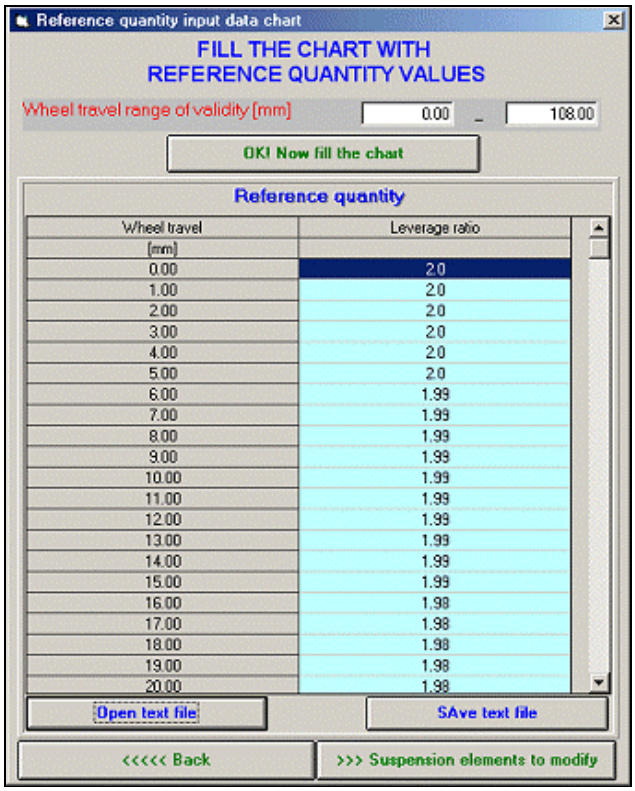
1) THE REVERSE FUNCTION: SUSPENSION 4.0 is the first and the only software specific for suspension system that has this procedure. Reverse Function is a way to modify a layout into another layout with an imposed "Leverage Ratio". With Reverse Function, the Leverage ratio of a rear suspension layout becomes equal to another Leverage ratio called "Reference leverage ratio". The equality must exsist for all wheel travel points; naturally, the perfect mathematical equality is never reached, so Reverse function works imposing a threshold (a percentage value) that, obviously, will be the most possible little. The software allows to load the reference leverage ratio from a text file (maybe created by an electronical sheet like EXCEL), to create a new reference leverage ratio filling a chart or to load an entire layout for reference.
For example, by Reverse Function we like to modify a **DUCATI 749** layout so that its leverage ratio becames equal to the **KAWASAKI ZX 6RR** one, threshold less than 1%. The use of Reverse Function is very simple: after choosen the reference layout or leverage ratio, software asks which are element to modify and which are the vertex. Then, user must impose an area for chosen vertexes mouvement in the space, the threshold, the computing step and precision. An automatical procedure starts, during this procedure is possible to see the points mouvements and the diagram evolutions step by step. It is possible to see how Ducati's Leverage ratio tries to become equal to Kawasaki ZX 6RR untill equality. When equality is reached, the result is automatically saved. If, at the end of Reverse function the equality is not reached, software ask you if you like to save the best result over threshold. We advise to save this result, because it is the layout you have to modify in a following Reverse function application.



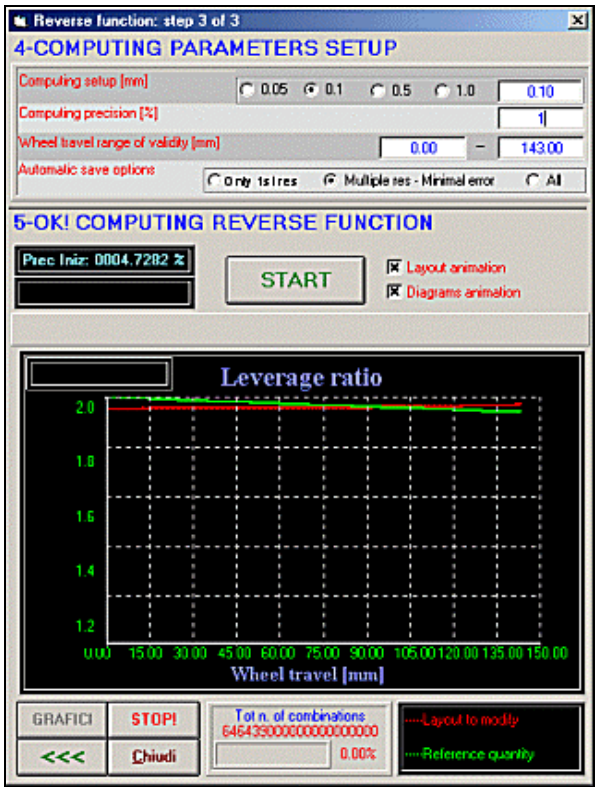
Reverse Function procedure: swapping areas PS2 vertex data input. I t is possible to define a swapping area for each vertex. "Swapping area" is the space area in which selected vertexes must move during Reverse Function procedure



Reverse Function procedure: Selected vertexes mouvements

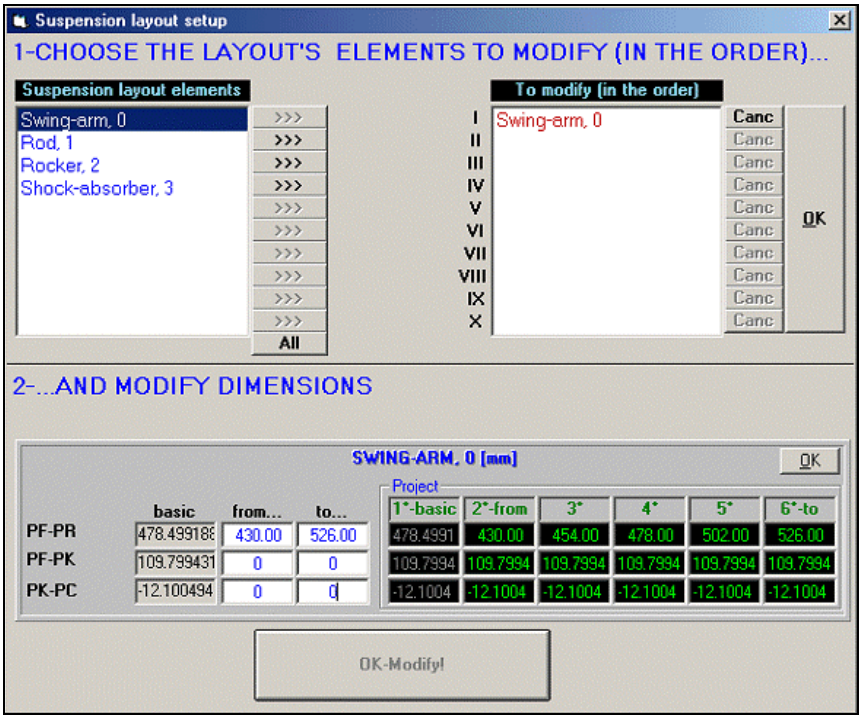


Reverse function procedure: it is possible to import experimental data from text files for references.



Reverse Function procedure: automatic computation. It is possible to see how red leverage ratio modifies untill it is equal to green one.

2) "PROFESSIONAL" LAYOUT SETUP. In this case, each suspension layput elements can be setup, by steps, like in the reality. It is possible to obtain until six different layout with modifications. For example, this procedure answers to question "Which appens to my suspension when swing-arm length varies from 400 to 500 mm?" In the picture, for example swing-arm length varies from 430 mm to 526 mm by 6 steps, the original swing-arm length was 478.5 mm. The steps are pre-imposed, but it is possible to change these data (the black text-boxes).

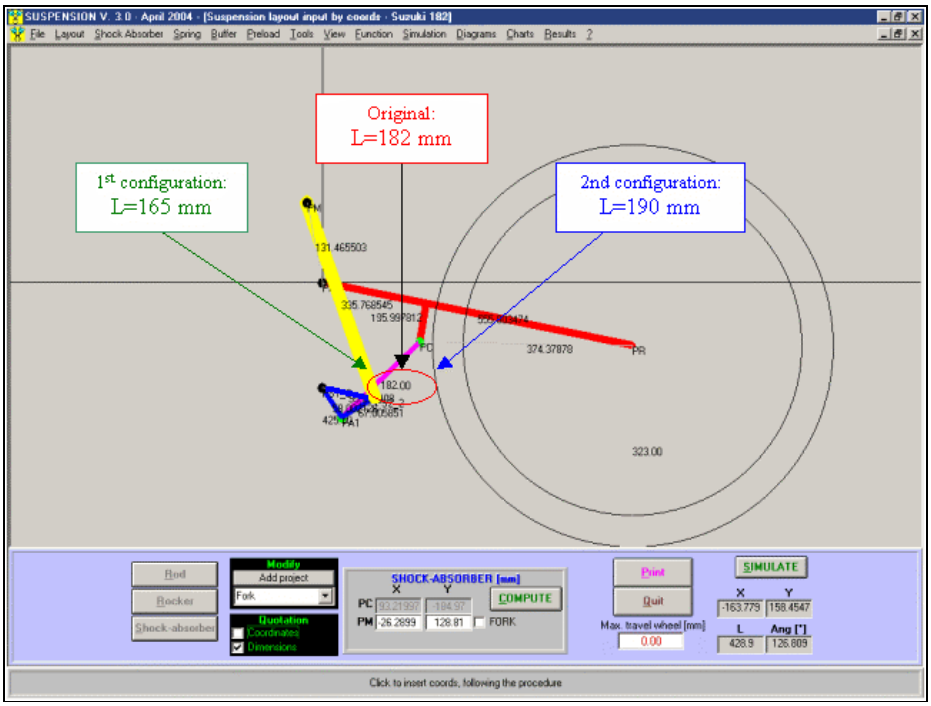


Professional Ducati 749 swing arm set-up

Fast layout modification example

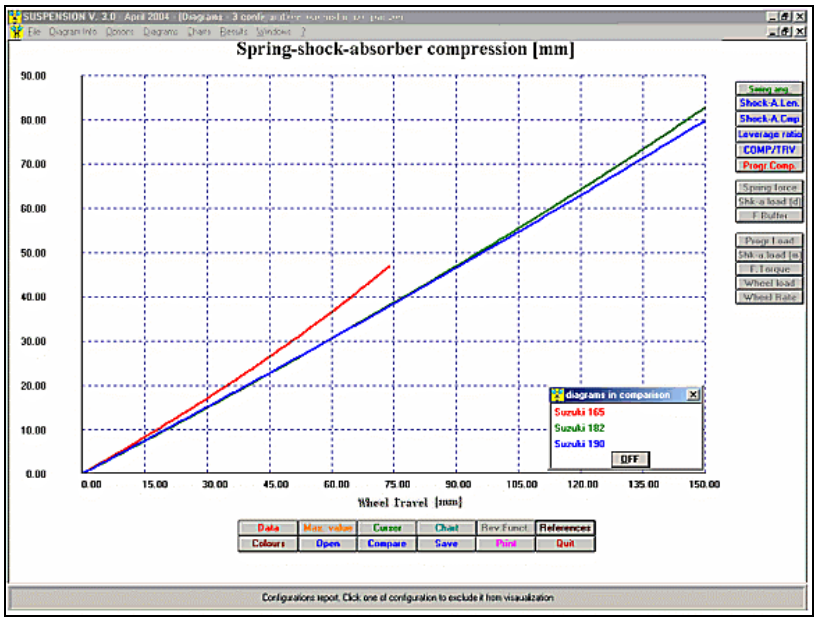
By "Suspension" it's possible to modify quickly the layout elements (SWING-ARM, RODS, ROCKERS, SHOCK-ABSORBER") dimensions. In this way, you can study the effect of a possible layout variation.

For example, see the following picture:



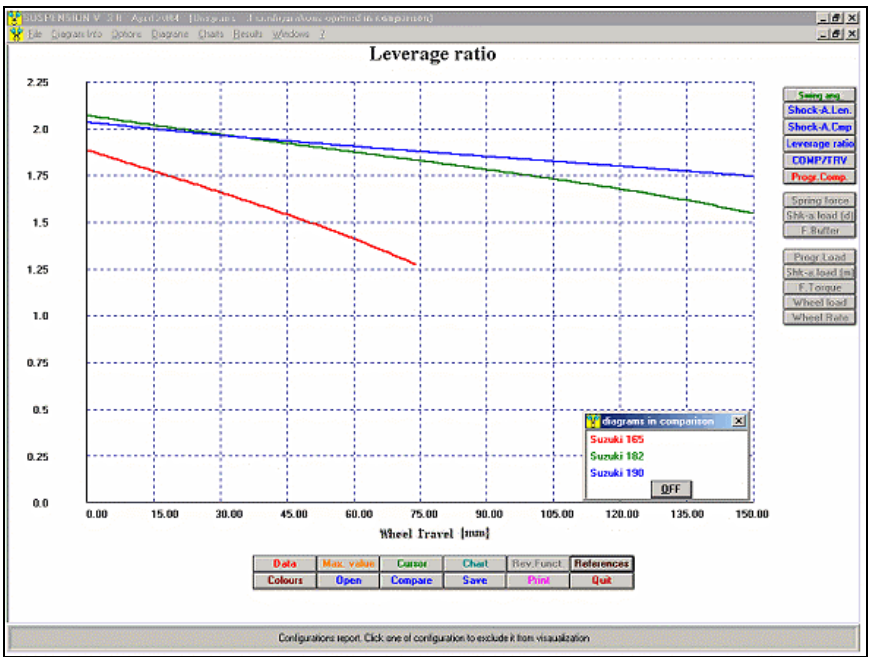
Suzuki GSX-R 1000 2004. Original Rod's length is 182.00 mm

In this case, the ROD's length is 182 mm (**ORIGINAL**). We like to create two configuration, in which ROD's length is **165 mm** (**CONFIGURATION 1**) and **190 mm** (**CONFIGURATION 2**). After modification (use "ADD PROJECT" and "MODIFY" options), you can compare the effects, as shown in the following pictures:



Suzuki GSX-R 1000 2004. "Shock absorber compression" comparison diagram

Red=Original, ROD's length = 182 mm
Green=Configuration 1, ROD's length = 165 mm
Blue=Configuration 2, ROD's length = 190 mm.



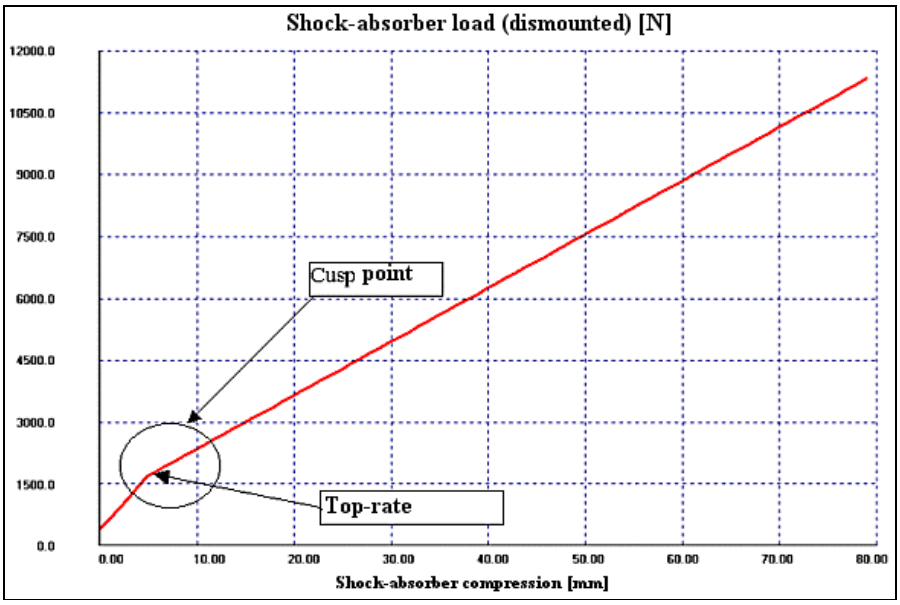
Suzuki GSX-R 1000 2004. "Leverage ratio" comparison diagram

Red=Original, ROD's length = 182 mm
Green=Configuration 1, ROD's length = 165 mm
Blue=Configuration 2, ROD's length = 190 mm.

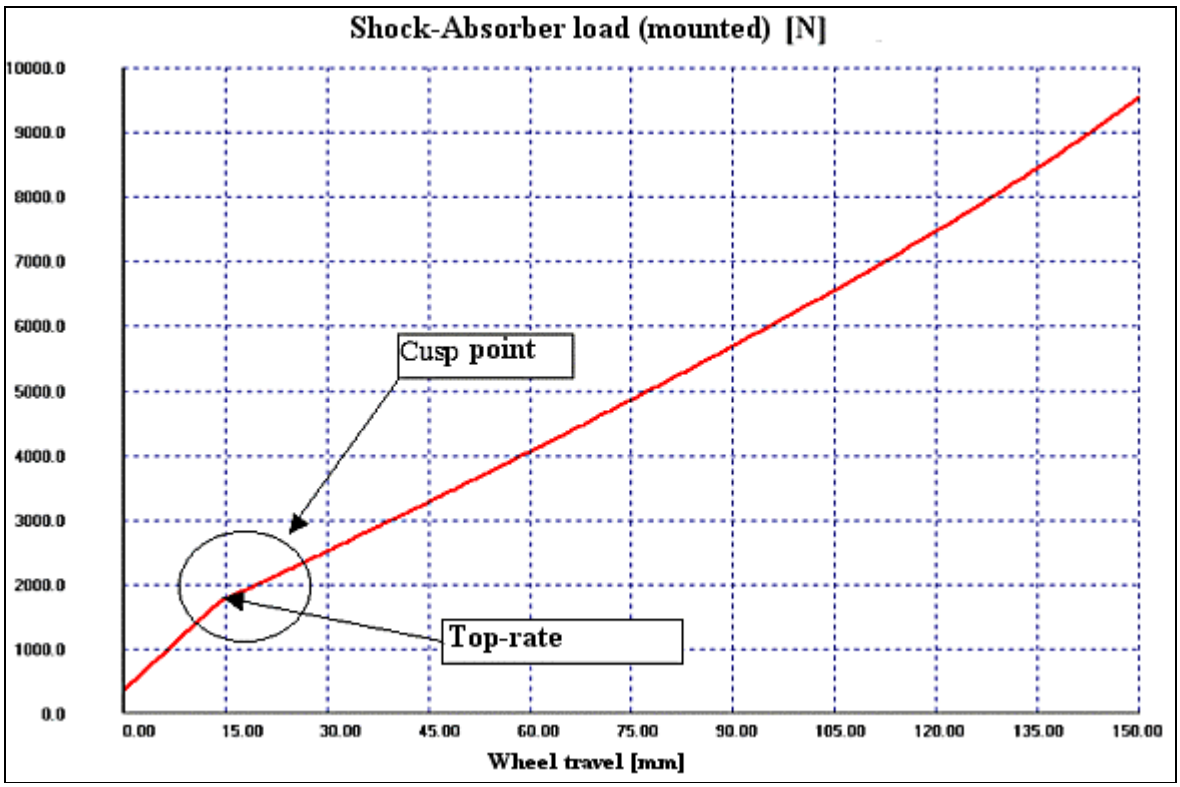
Top-out effects on static quantities

Top-out is a little spring with an elevate elastic constant value. This spring mouvement is contrary to the main spring one, and so the elastic constant can be considered as a "negative" value. This fact modify the diagram of some static quantities, like: **Shock-absorber (dismounted and mounted) load**, **Swing-arm torque, Wheel load, Wheel rate**.

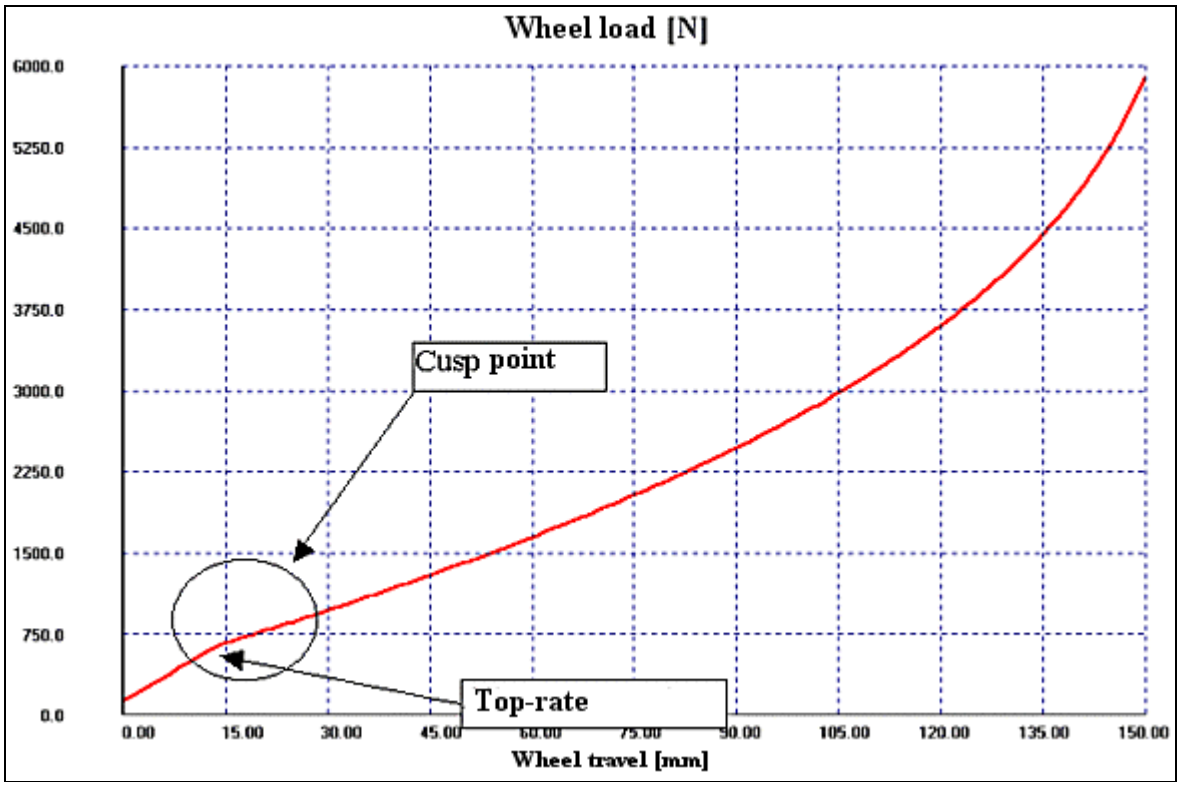
The wheel travel value the top-out starts is called "top-rate". All the quantities shows a change of inclination in the diagram in top-rate point, except Wheel rate, that shows a discontinuity (it is the mathematical conseguence the Wheel rate is a *variation* of Wheel load vs a *variation* of Wheel travel). The "Top-rate" value is shown using the "Diagram cursor" option. By "Fast layout set-up" is possible to modify (in a range) the top-rate value.



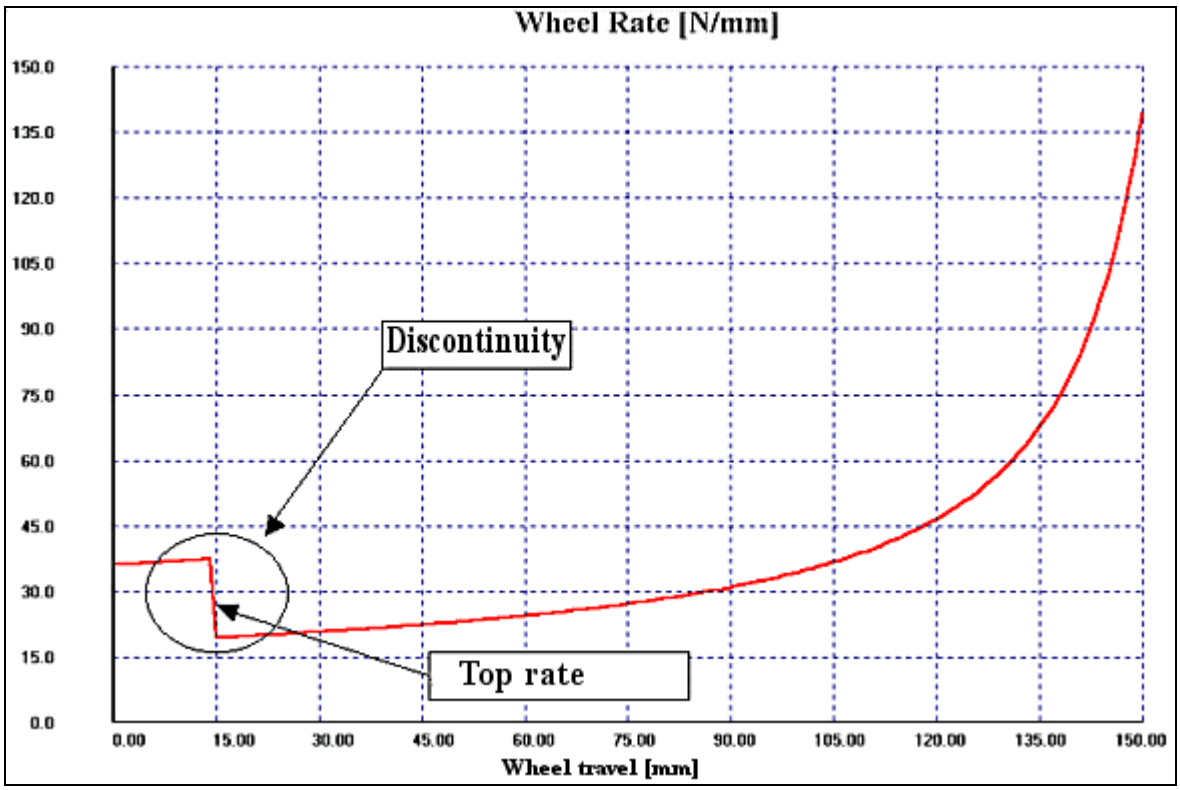
Top-out effect on "Dismounted shok-absorber load"



Top-out effect on "Mounted shok-absorber load"



Top-out effect on "Wheel load"



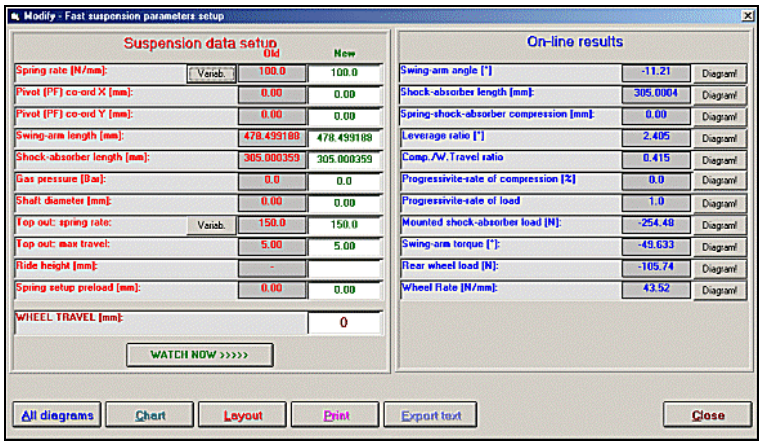
Top-out effect on "Wheel Rate"

The Wheel Rate diagram discontinuity depends on the "Wheel load" quantity curve shape, that have a discontinuity point causerd by the "Top-rate" effect.

Fast layout setup

This option is particularly appreciated by whom use this software to modify quicly the suspension system. There are several factors to modify: elastic constant, swing-arm length, shock-absorber length, "top-out" and "top-rate" etc.. It is possible to observe immediately the result vs some Wheel travel values (you insert). Moreover, software is able to create a new suspension layout with modifications, so you can compare (diagrams and charts) the two suspensions, **before** and **after** modifications.

EXAMPLE: we like to modify a Ducati 749 swing arm length from 478.5 mm (original) to 500. Fill the suitable text-box and click "OBSERVE" button. Immediately software creates an a new layout, equal to Ducati 749 one but swing-arm length is 500 mm and not 478.5 mm. Giving values to Wheel travel, you can see the new quantities values after modifications. Click "Diagram!" to see the graphics.



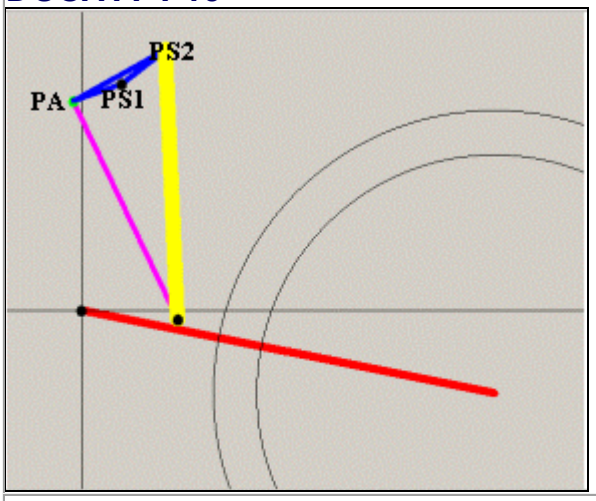
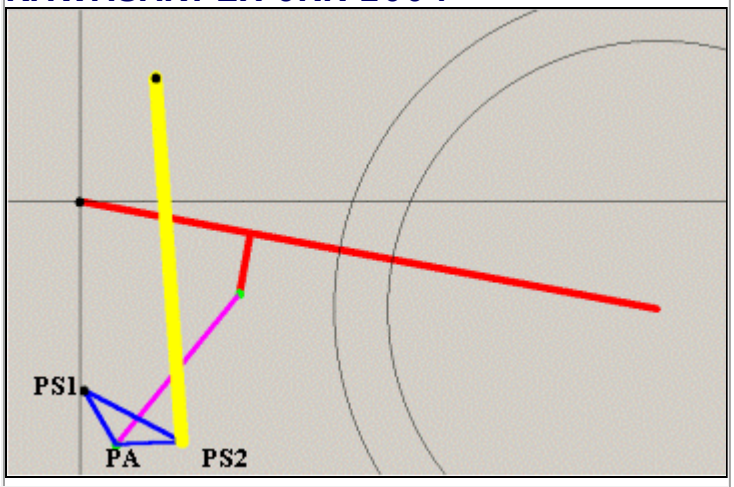
Fast layout set-up procedure: itis a very quick method to modify suspension main factors

and now:

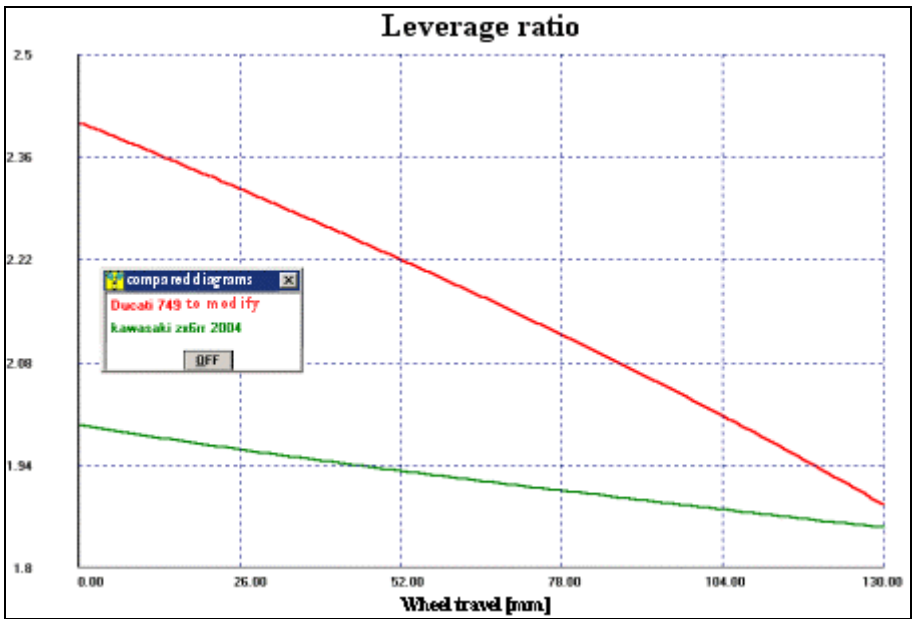
Reverse Function: a real application

ABSTRACT: WE LIKE TO APPLY THE REVERSE FUNCTION TO A DUCATI 749, SO THAT ITS LEVERAGE RATIO BECOMES EQUAL TO THE KAWASAKI ZX 6RR ONES. BEFORE REVERSE FUNCTION, THE MAX. DIFFERENCE BETWEEN THE TWO LEVERAGE RATIOES WAS 17.08%.

DUCATI 749 is the layout to modify. Its leverage ratio must be equal (precision: 1%) to a **KAWASAKI ZX 6RR** one.
The original layouts are:

DUCATI 749	**KAWASAKI ZX 6RR 2004**
	
Swing arm length: 478.5 mm **Rod length: 274 mm** **Rocker: side PA-PS1: 57.9 mm** **Rocker: side PA-PS2: 63.58 mm** **Rocker: side PS1-PS2: 119.854 mm** **Rocker: PS1 fixed point coords: (46; 256) mm** **Shock-absorber length: 305 mm**	**Swing arm length: 544.5 mm** **Rod length: 181 mm** **Rocker: sidePA-PS1: 58.5 mm** **Rocker: sidePA-PS2: 61.2 mm** **Rocker: side PS1-PS2: 102.7 mm** **Rocker: PS1 fixed point coords: (3.8; -175.5) mm** **Shock-absorber lengthe: 340 mm**

And leverage ratios difference is **17.08% (Max difference)** when wheel travel is 0.

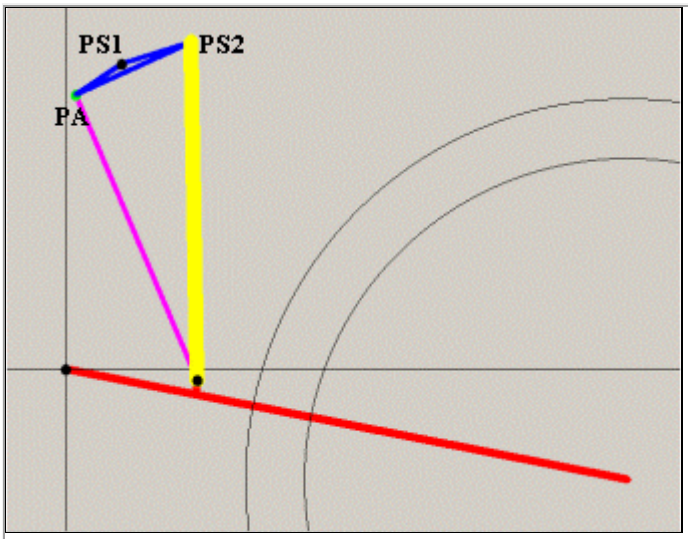


Ducati 749 *and* **Kawasaki ZX 6RR** Leverage ratio comparison
Max difference: 17.08%

We made some test with Reverse Function to find a better result:
I REVERSE FUNCTION TEST: PA rocker vertex coord modification, swapping area = square (side: 50 mm), computing step = 3 mm, wheel travel range = [0-130] mm → e obtanin a new layout: its leverage ratio's difference vs Kawasaki ZX 6RR one is 6.26%.

II REVERSE FUNCTION TEST: Layout with a 6.26% max leverage ratio difference loading, PS2 rocker vertex modification, swapping area = square (side: 30 mm), computing step = 1 mm, wheel travel range = [0-130] mm → we obtanin a new layout: its leverage ratio's difference vs Kawasaki ZX 6RR one is 1.85%.

FOLLOWING TESTS: Layout with a 1.85% max leverage ratio difference loading, PS2 rocker vertex modification, swapping areas more and more little. At the end, we obtain a final layout: its leverage ratio's difference vs Kawasaki ZX 6RR one is 0.511%.
Here to you all layout data!



MODIFIED DUCATI 749

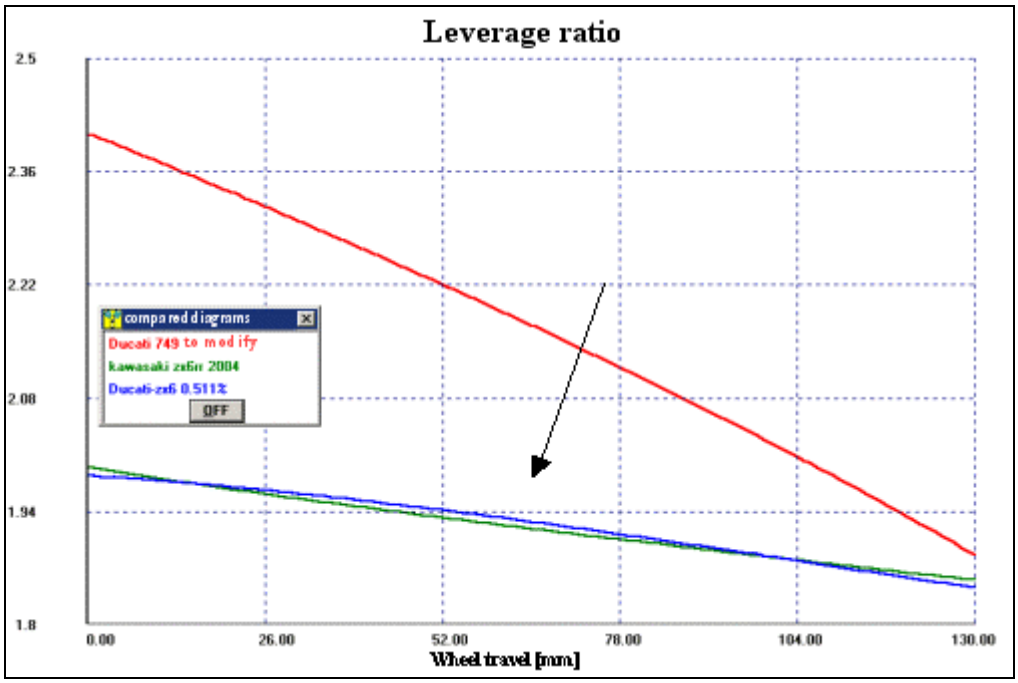
Leverage Ratio Vs Kawasaki ZX 6RR one: max difference: 0.511% (firstly was 17.08%!)

Swing-arm length: 478.5 mm

Rod length: 260.316 mm

Rocker: side PA-PS1: 46.043 mm
Rocker: side PA-PS2: 106.085 mm
Rocker: side PS1-PS2: 61.165 mm
Rocker: PS1 fixed point coords: (46; 256) mm

Shock-absorber length: 284.034 mm



Blu Leverage ratio: Modified Ducati 749;

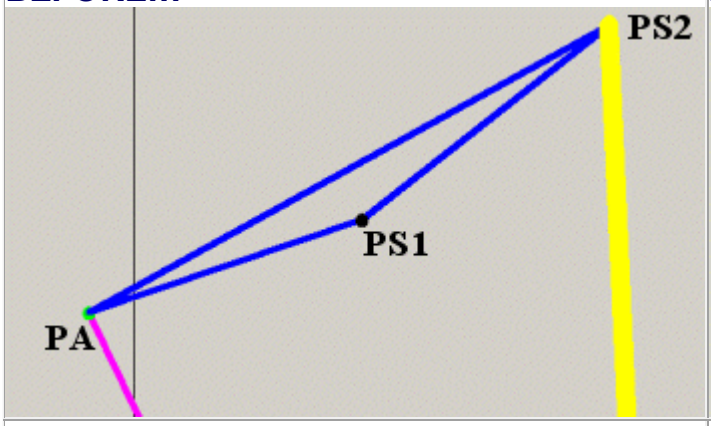
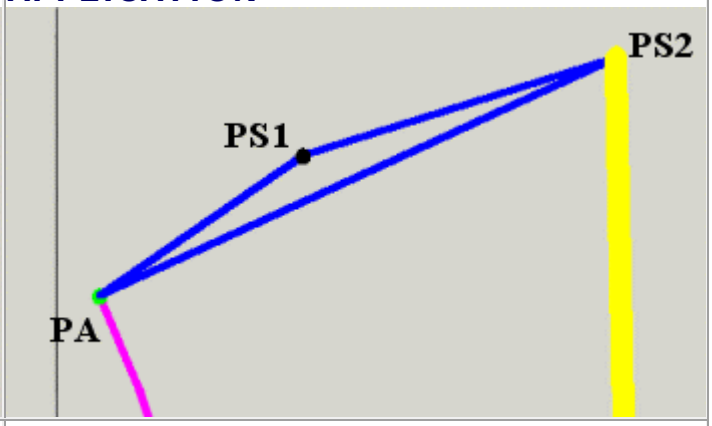
Green Leverage ratio: Kawasaki ZX 6RR;

Red Leverage ratio: Ducati 749 (original).

Difference (at Wheel Travel=0mm):

Blu/Green=0.49%

Max difference: Blu/Green=0.511%

THE DUCATI 749 ROCKER BEFORE...	...AND AFTER REVERSE FUNCTION APPLICATION
	
Swing-arm length: 478.5 mm **Rod length: 274 mm** **Rocker: side PA-PS1: 57.9 mm** **Rocker: side PA-PS2: 63.58 mm** **Rocker: side PS1-PS2: 119.854 mm** **Rocker: PS1 fixed point coords: (46; 256) mm** **Shock-absorber length: 305 mm**	**Swing-arm length: 478.5 mm** **Rod length: 260.316** **Rocker: side PA-PS1: 46.043** **Rocker: side PA-PS2: 106.085** **Rocker: side PS1-PS2: 61.165** **Rocker: PS1 fixed point coords: (46; 256) mm** **Shock-absorber length: 284.034 mm**

Soft-Engine engine simulation software – software “Suspension”

Versions and costs

Version	Cost
Suspension 3.0 New-conception software for rear suspension system bike and motorcycles project. Its possible to draw directly any typical and not-typical suspension layouts and test. Very professional software. Moerover: -Fast layout regulations -Top out -Import/Export DXF file	€ 715.00
Suspension 4.0 Like 3.0 version, but including: 1-Reverse function 2-Professional Layout set-up	€ 1,000.00

PC minumum configuration

Feature	Description
Processor:	Any personal computer IBM compatible.
System:	Windows ME, NT, Xp, Vista, Seven, Eight, Ten. 32 bit systems, compatibility with 64 bit.
Memory RAM and Hard Disk:	At least 512 MB RAM and 2 GB free in the hard disk (for best Windows performances).
CDrom or Dvdrom device:	Speed at least 52X.
Graphic card:	VGA, SVGA and compatible cards, set at least 32 bit, Min. resolution: 1024x768.
Miscellaneous:	Keyboard, mouse, at least 1 USB port free (to connect the printer).
Printer:	Any ink-jet printer. Total compatibility with laser printers.
Total compatibility with notebooks and cases minitower PC.	