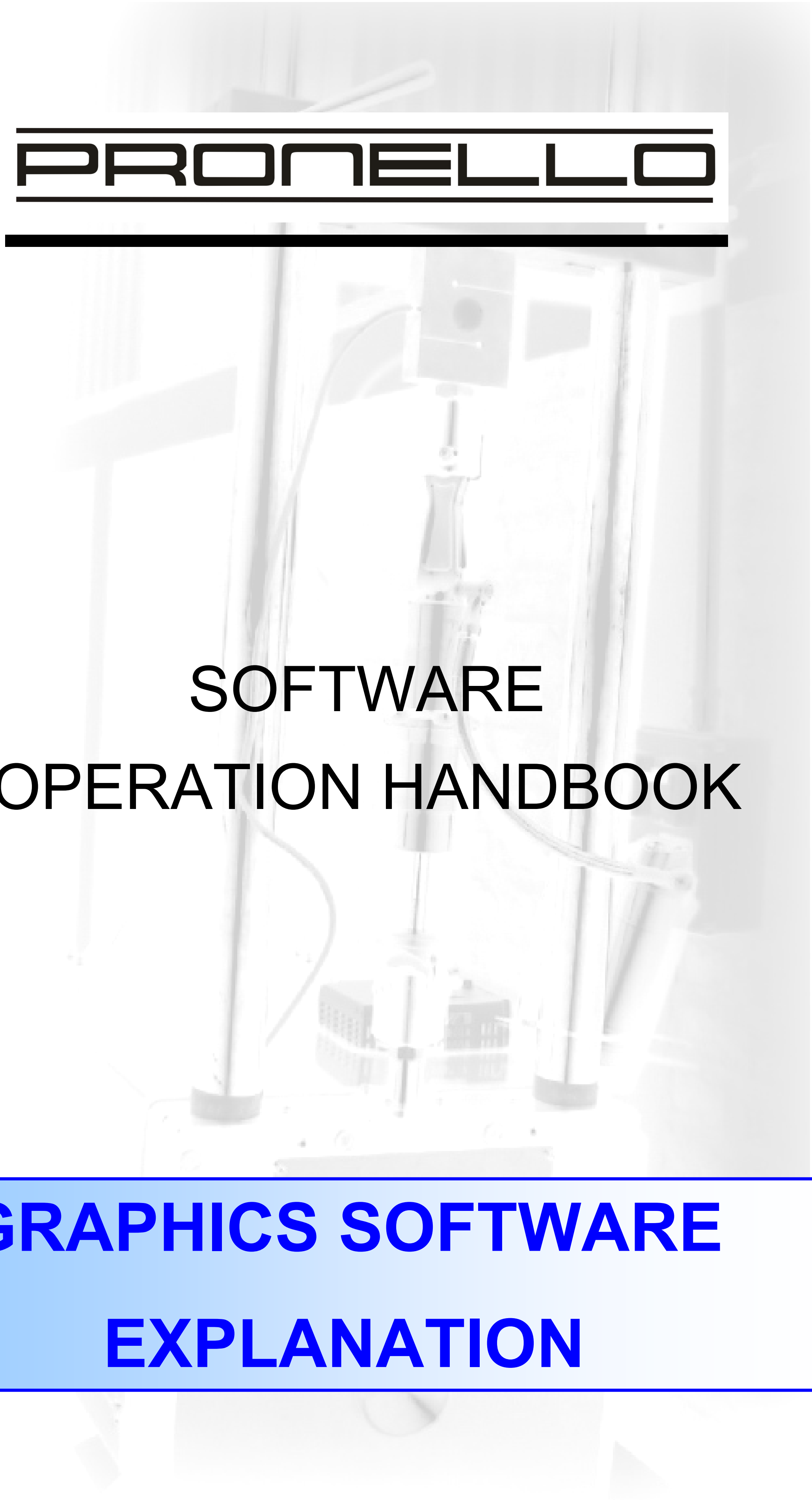
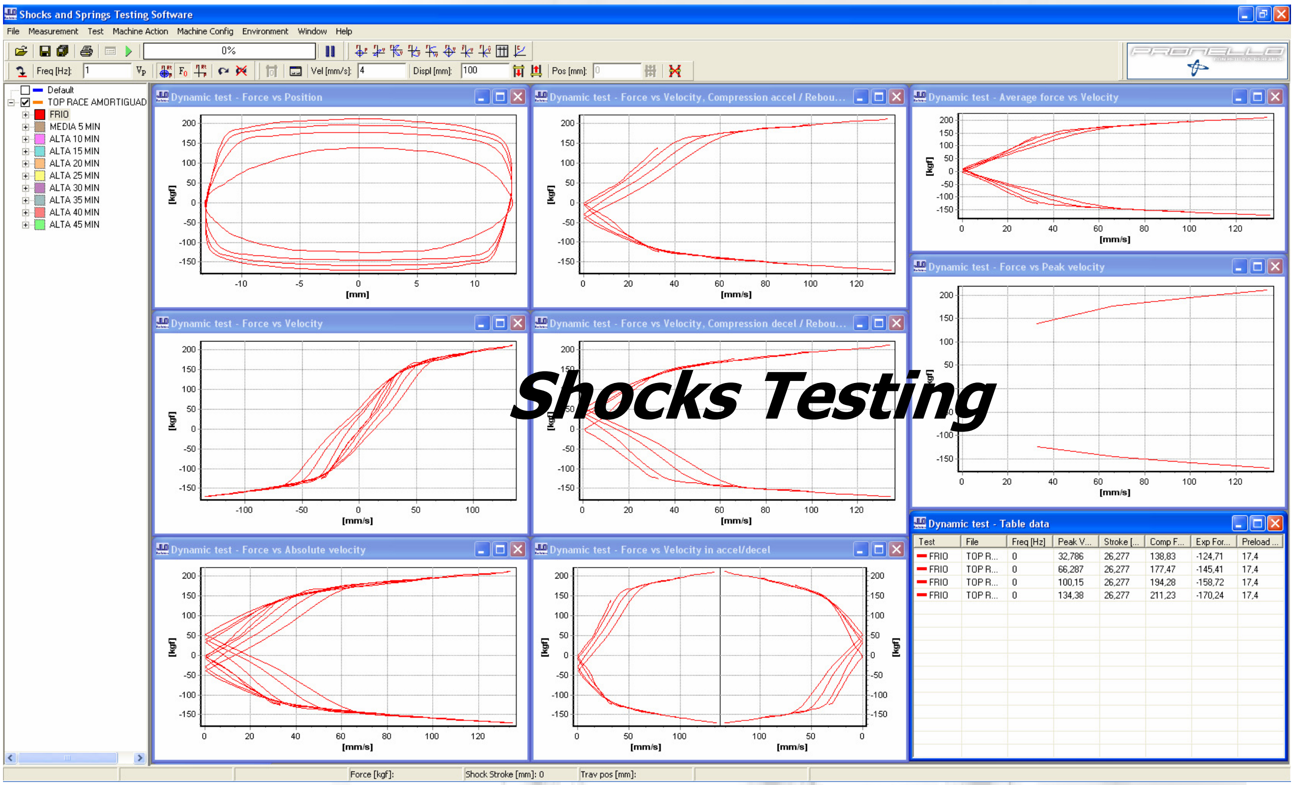


PRONELLO

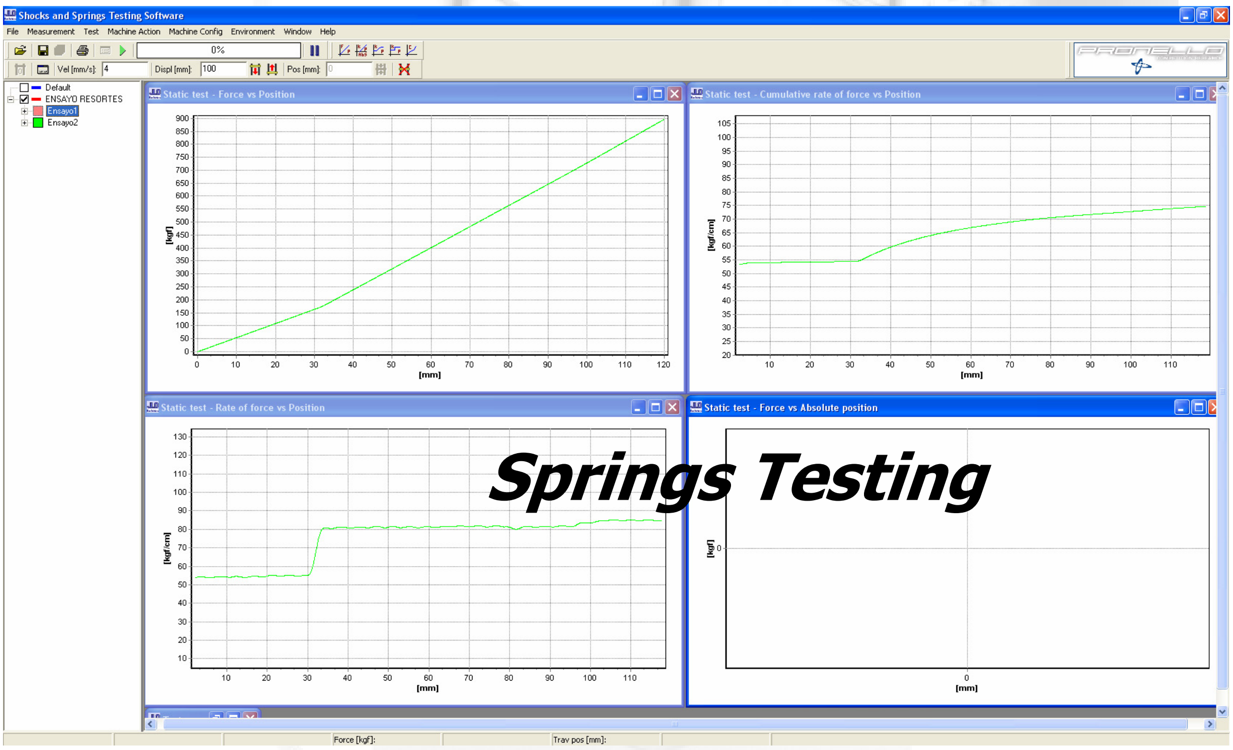
SOFTWARE

OPERATION HANDBOOK

GRAPHICS SOFTWARE EXPLANATION


Shocks and Springs Testing Software
Shocks Testing

SOFTWARE


Shocks and Springs Testing Software
Springs Testing

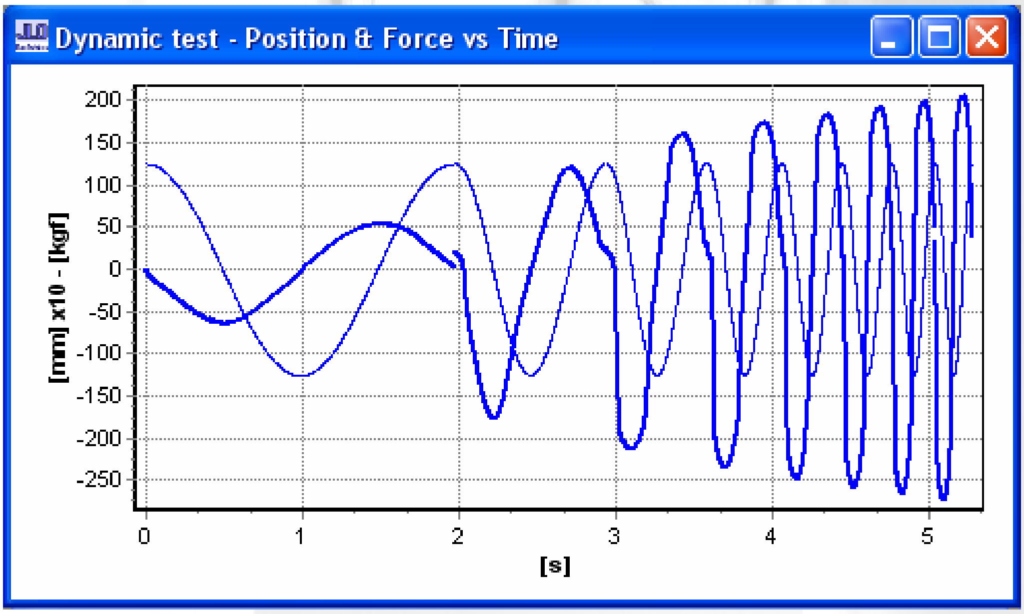
Shock Testing

10 different kinds of graphics, chart data presentation, and a curve control Pass – No Pass system

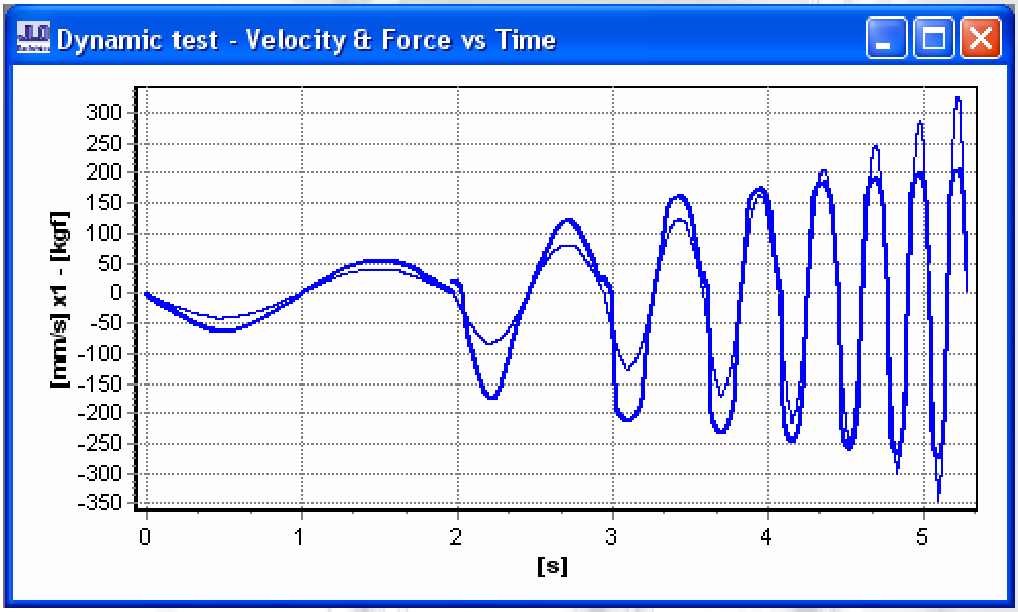
How is a sinusoidal test?

First of all we want to define how occurs a sinusoidal test, whatever its stroke and frequency, occurs as following:
Firstly is the expansion cycle. It starts with maximum acceleration from the TDC (top dead center), and zero speed; reaching then the maximum speed point (in the middle of the stroke). This maximum speed is determined by the configured stroke and frequency; at that moment the acceleration is zero. From that point the expansion cycle continues but with a decreasing speed (decelerate period) up to the BDC (bottom dead center), reaching there with zero speed. At that moment, in the BDC point, the compression cycle starts.
The compression cycle also has two periods: acceleration from zero speed to Vmax (in the middle of the stroke); and a decelerate cycle period, from Vmax to zero speed, finishing in the TDC.

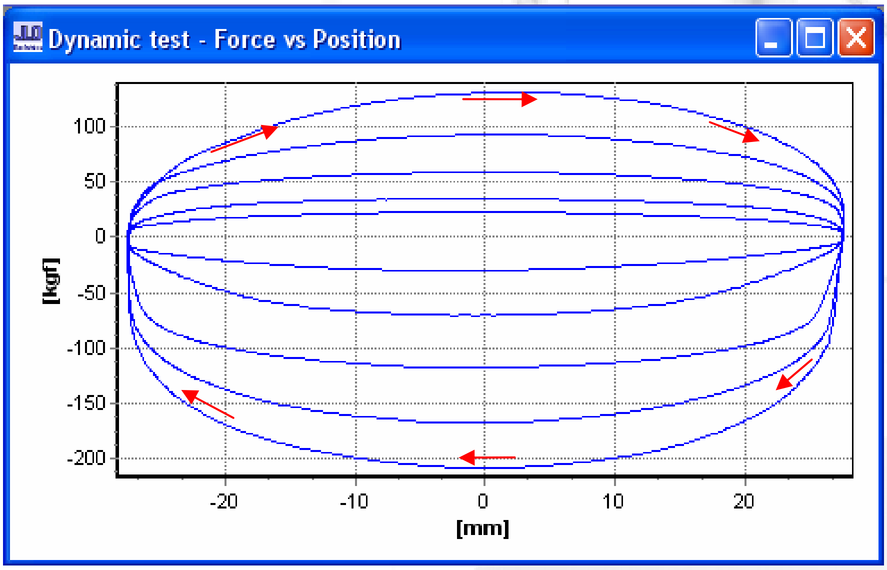
1- Position and Force vs. Time



2- Velocity and Force vs. Time



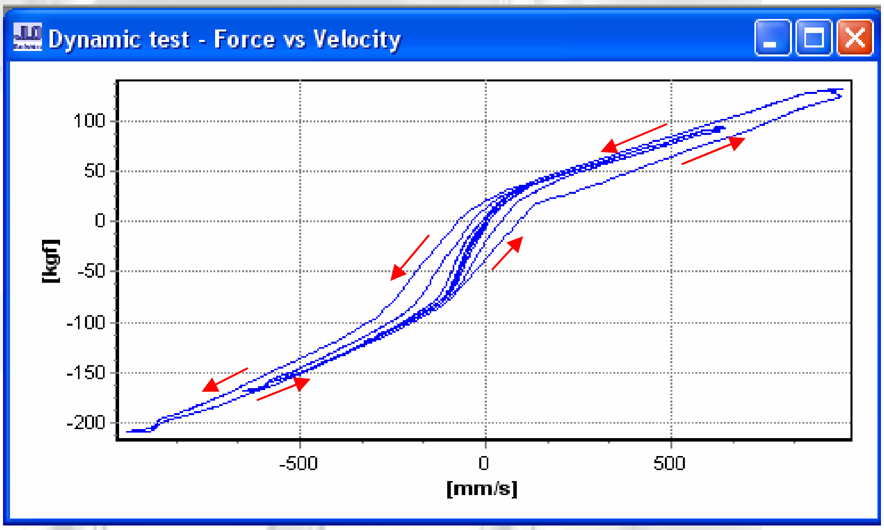
3- Force vs. Position



The graphic is performed in clockwise, making first the expansion part (the inferior with negative force values) and then the compression one. Knowing this developing form of the graphic, the user can analyze different kinds of failures that a shock may be having. It is ideal for analyzing the hydraulic behavior of the shock, not for the developing of it.

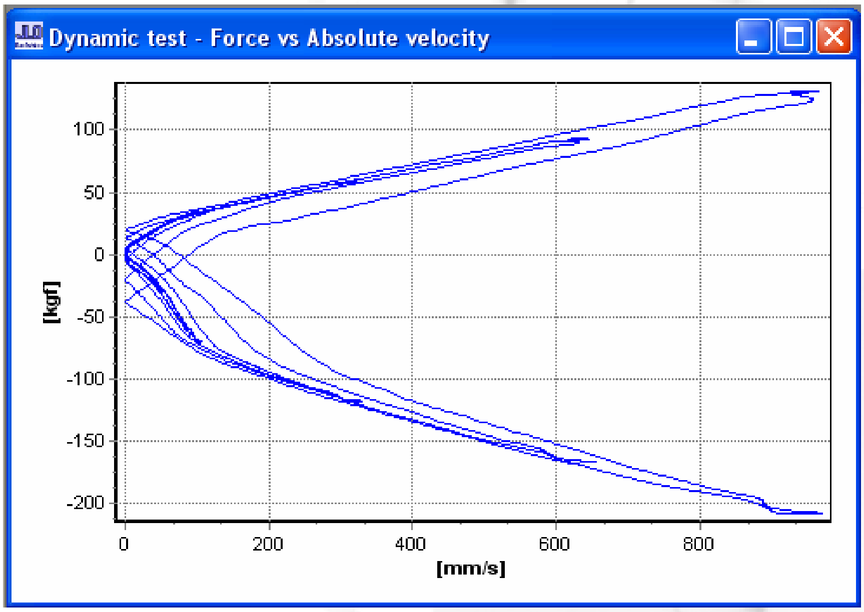
4- Force vs. Velocity

The graphic is performed in counterclockwise, making: first the expansion part, where we have two speed branches, one the expansion with acceleration branch which is done first and then the expansion with deceleration branch, passing next to the compression cycle, where again passes first for the compression with acceleration branch and finally for the deceleration one.
This graphic has many derivations as it can be seen next.



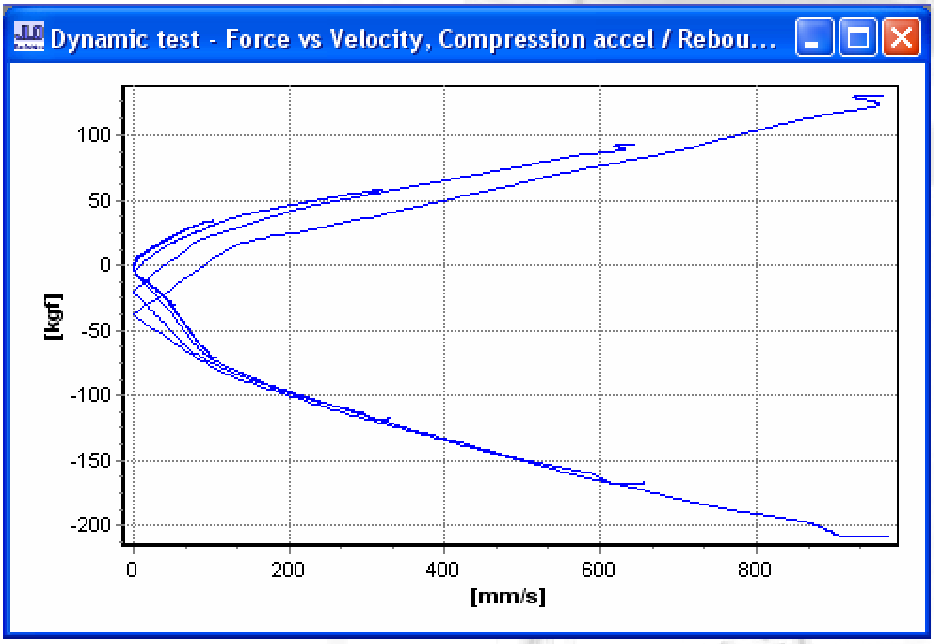
Any graphic that involves speed, is used to design the shock. If the shock presents a progressive or digressive behavior, it is always referred to the shaft speed.

5- Force vs. Absolute velocity

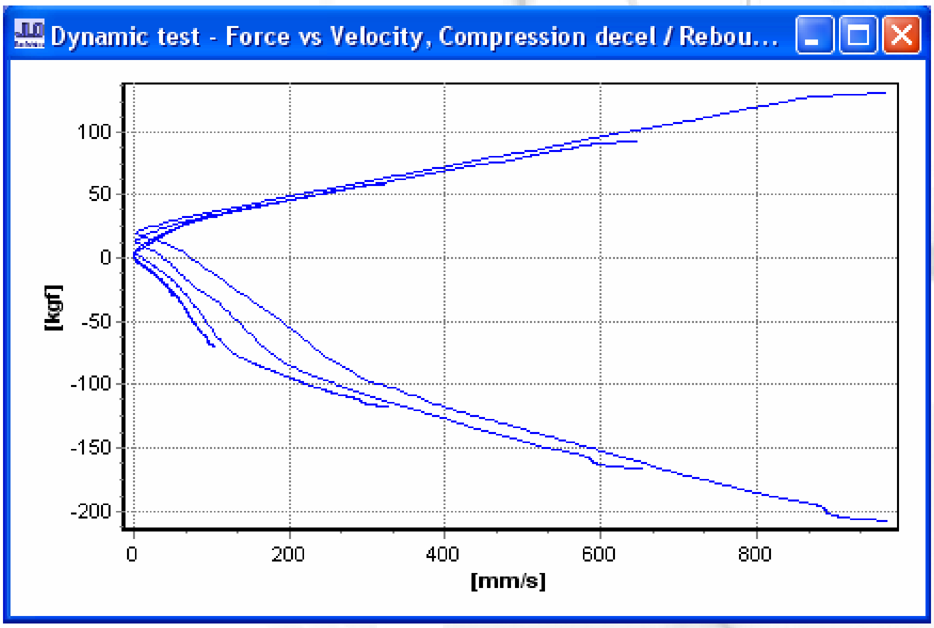


It is another way to show the previous graphic.
Here the velocity is always positive, because it takes the absolute values.

6- Force vs. Velocity, Compression accel. / rebound decel.

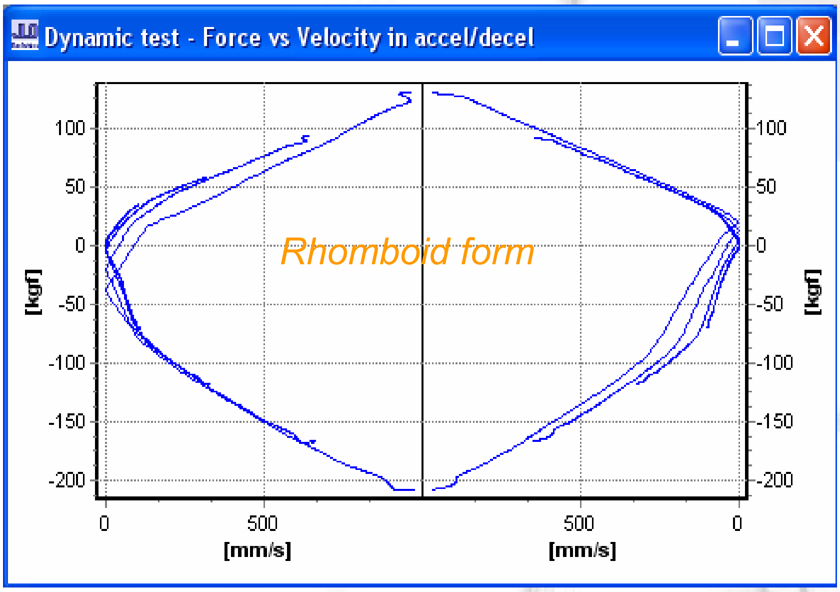


7- Force vs Velocity, Compression decel. / rebound accel.



Therefore the graph 6 and 7, let the users appreciate graph Force vs. Absolute velocity, but divided in two parts, in order to get a better view.

8- Force vs. Velocity in accel. / decel.



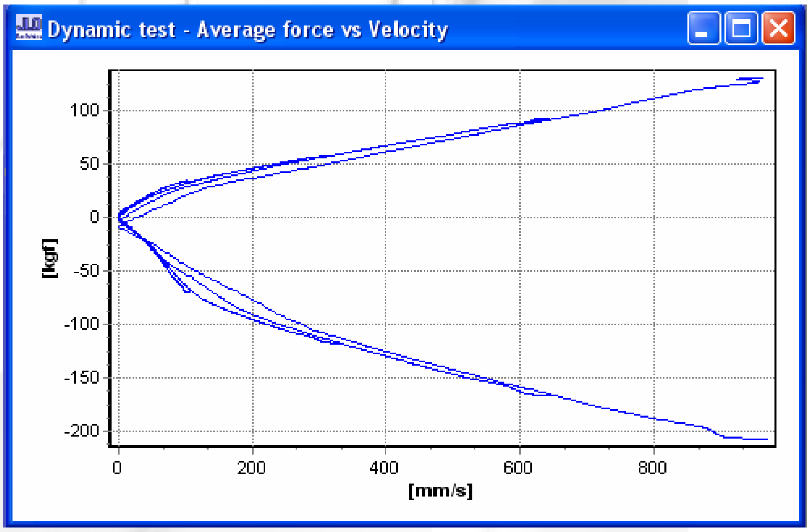
The graphic is performed in clockwise, in order of occurrences, it performs as follows:

1) The inferior right part, number 4 quadrant is the expansion with acceleration.
2) The inferior left part, number 3 quadrant is the expansion with deceleration.
3) The superior left part, number 2 quadrant is the compression with acceleration.
4) The superior right part, number 1 quadrant is the compression with deceleration.

This graphic allows the user to easily evaluate separately the shock behavior in function of accelerating and decelerating speeds.

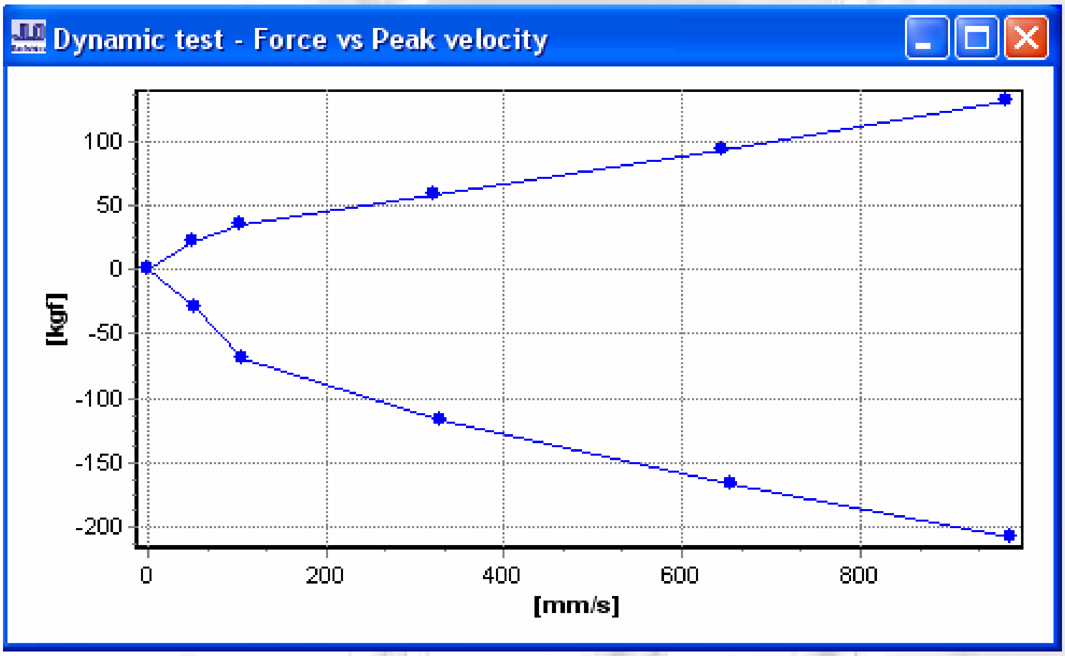
9- Average force vs. Velocity (absolute values)

This graphic is like number 5, but in the expansion cycle the forces of the 2 branches (acceleration and deceleration) have been averaged. The same occurs in the compression cycle. That is why it is called: Average Force vs. Velocity. Also, the velocity axis has been expressed with modulus values (no negative numbers).
This graphic may not start with 0 forces at 0 speeds, depending of the hysteresis of the shock (this fact might produce that the force average at 0 speeds is different from 0). This "hysteresis" is the cause of these 2 branches (look graphic number 4 and 5).

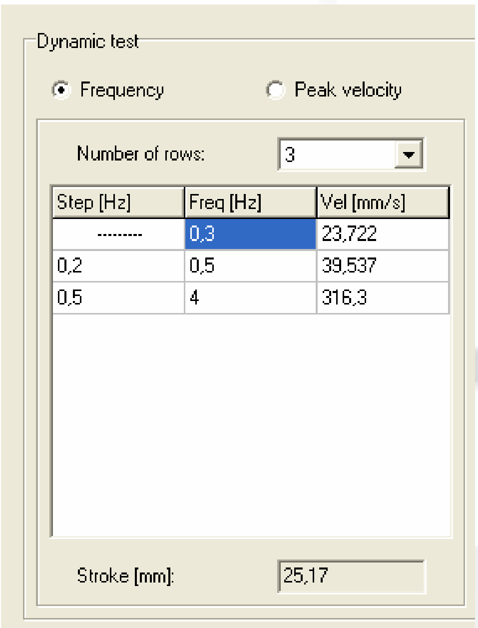


In another way, we can say that shocks are not only velocity dependent, they are also acceleration dependent.
Some shock designs are more dependent than others of shaft acceleration.

10- Force vs. Peak Velocity



Our software can perform multi step frequency tests, so you can have up to 10 different steps in the same test. If the rate between the steps is zero, you have 10 independent frequencies.



In the showed configuration, the rate between the frequencies steps, produce the following results: 0.3 / 0.5 / 1 / 1.5 / 2 / 2.5 / 3 / 3.5 / 4.

In the above graphic, a multi frequency test shows several points.

From each cycled frequency, the system extracts 2 force values, one at maximum velocity during compression cycle and the other at Vmax during the expansion one.

Remember that maximum velocity is at the middle of the stroke, and it is in the only point where we have zero acceleration.

Here we can study the loads that the shock has in speeds with no acceleration.

This is used to design the shock. Each point of the graph is the value of maximum force in compression and rebound (maximum velocity), so it let appreciate if the shock presents a progressive or digressive behavior.

11- Table data

Dynamic test - Table data

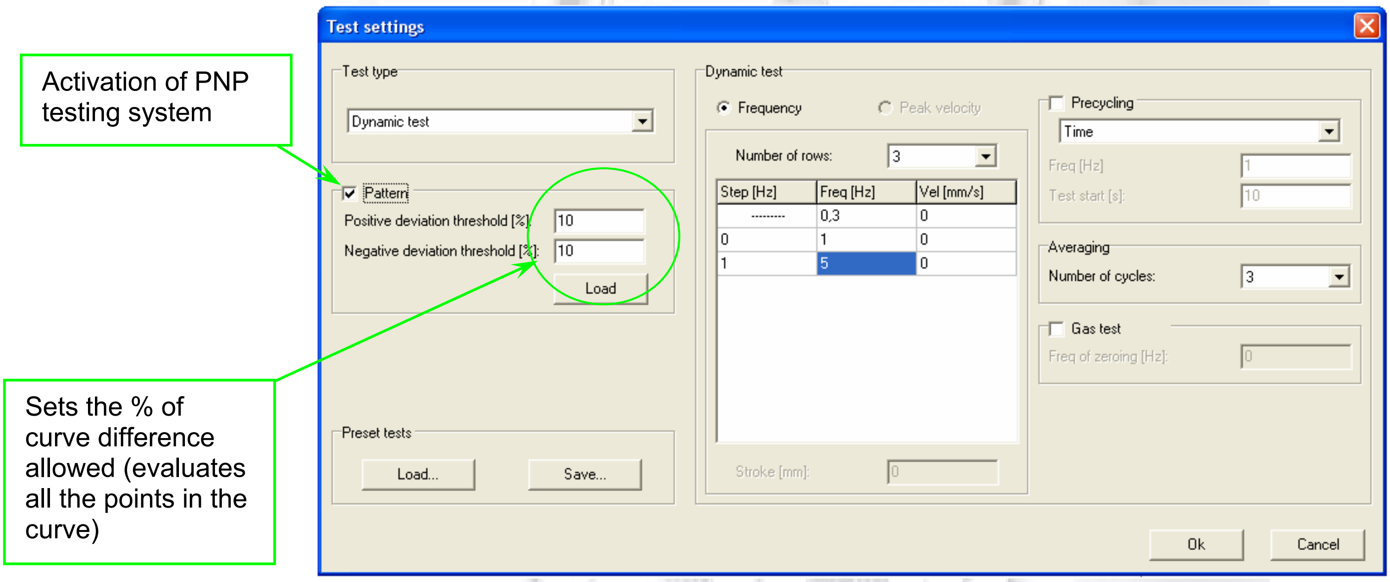
Test	File	Freq [Hz]	Peak Vel [mm...	Stroke [mm]	Comp Force [...	Exp Force [kgf]	Preload [kgf]
65-1	TOY...	0,29216	52,223	55,037	22,532	-29,946	6,2192
65-1	TOY...	0,5925	105,77	55,037	34,329	-70,005	6,2192
65-1	TOY...	1,8172	324,43	55,037	58,409	-117,64	6,2192
65-1	TOY...	3,6513	650,38	55,037	92,801	-166,94	6,2192
65-1	TOY...	5,5049	966,5	55,037	130,82	-208,1	6,2192

Table data shows complete information about the result of the test:

- Name with which the test was saved
- Frequency and peak velocity of each point
- Stroke in which the machine was configured
- Compression and rebound force at maximum velocity
- Load of the gas at the established frequency in machine parameters.

PNP System

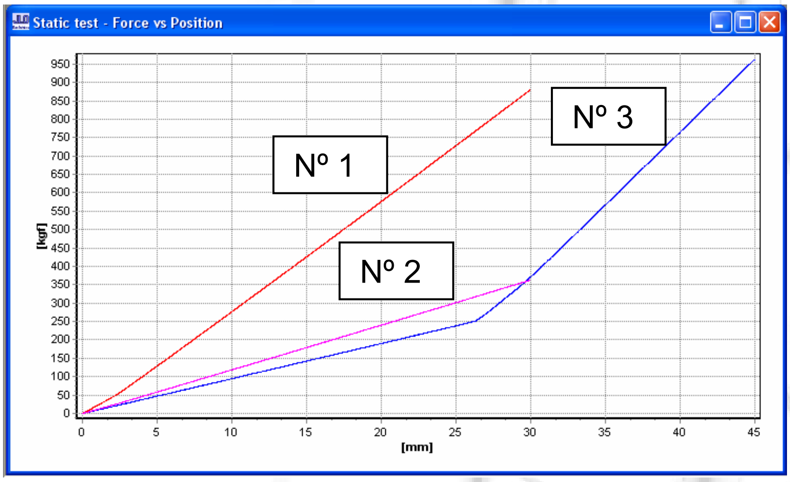
Allows us to select any previous saved test as a pattern; after this, the next performed tests will be carried with the same configuration as the pattern.
We have to set the % of curve difference acceptance.
Curves are evaluated in all their points against the pattern plus the %.
If the resulting curve of the tested shock have differences with the pattern over the configured %, a warning advice appears and the red light of the external controls starts to flash, otherwise the green light flashes and no warning appears.



SPRING TESTING

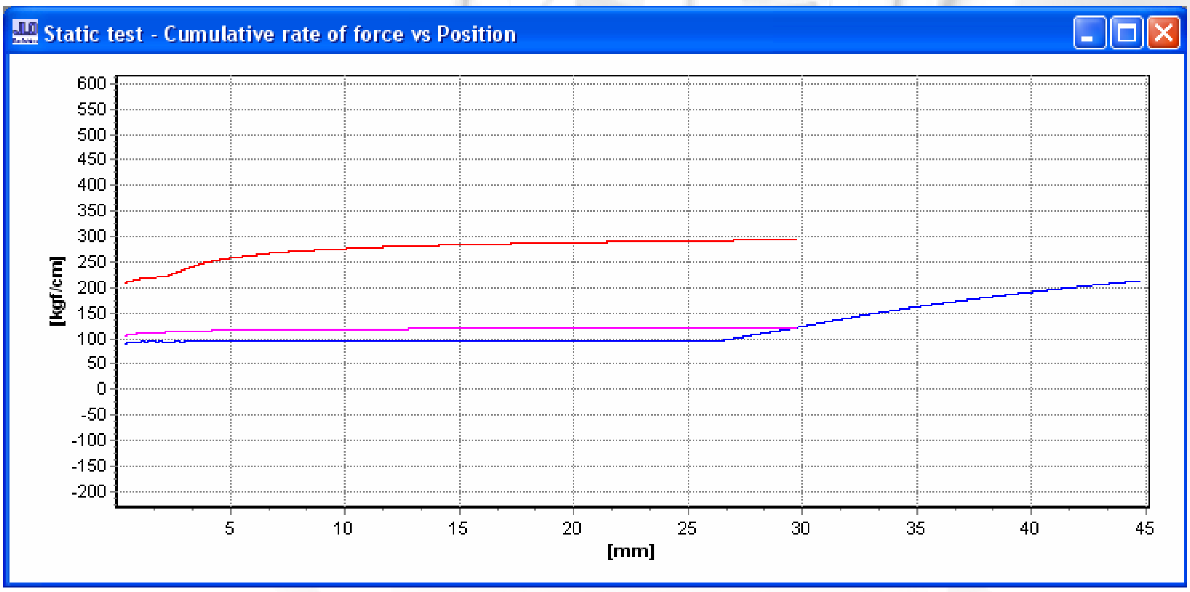
We have 3 different types of graphics.

12- Force vs. Position



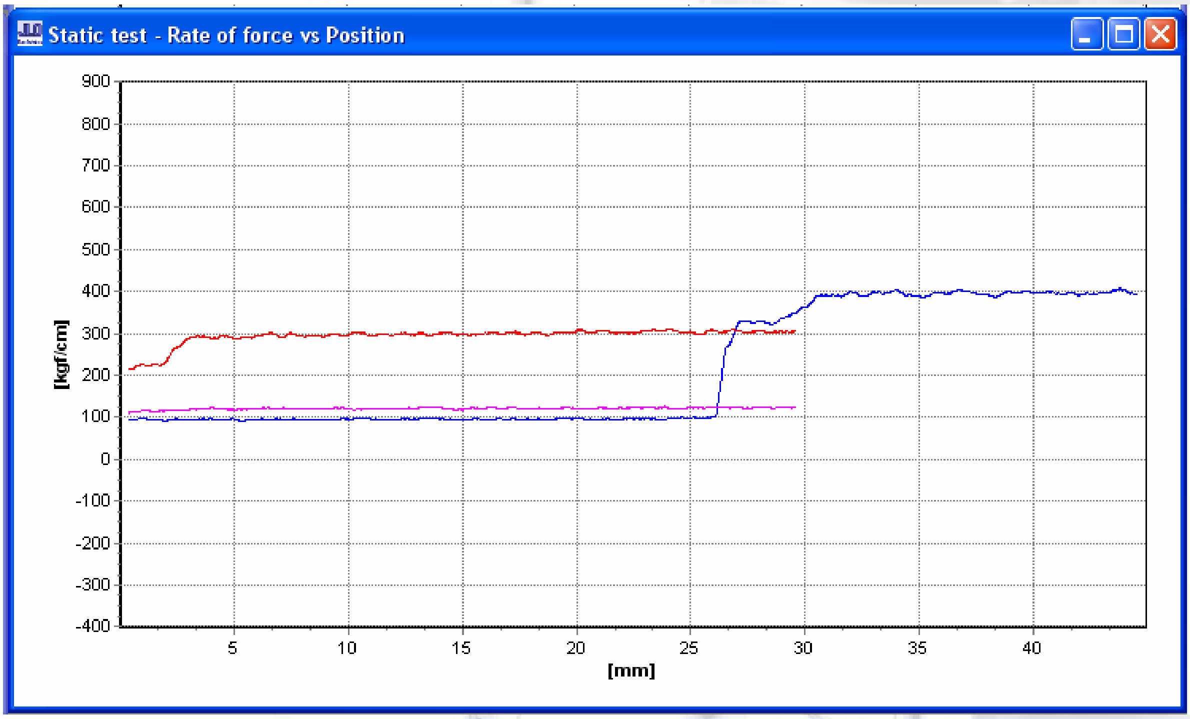
These graphics show the curve of Force vs Position of three different springs, through all the range which the tests were configured.
The number 1º and 2º show a linear curve, while the 3º (blue) is a progressive curve.

13- Cumulative rate of Force vs. Position



Here the software uses the *spring equation*, which relates the force exerted by a spring to the distance it is compressed by a *spring constant*, *k*, measured in force per length.

14- Rate of Force vs. Position



Here the software also uses the *spring equation*, but here, it considers *ΔK* through all the graphic Force vs Position.
So, as the software calculates the slope of the curve through the entire Force vs Position graphic, instance to instance; the variation of the spring constant is more appreciable:

- **When a progressive spring is tested, a different of value is found between the two graphics.**

- **When a linear spring is tested, there are not practically differences because the slope of the curve keeps constant through the entire test.**