UNDERSTANDING PVP AND CVP GRAPHS

- CVP-continuous velocity plot. Collects data continuously over a complete 360 degree cycle of the crankshaft. (One complete compression and rebound cycle of the damper. Displays all the collected data points.

- PVP-Peak velocity plot. Runs the damper at a number of peak test speeds and collects data at only the peak velocity for each speed.

CVP test

CVP test are defined by the peak speed we are going to run in that test. A10ips CVP test will have a peak velocity of 10ips. But remember we have to accelerate up to that speed and the slow back down to zero so we now pass through each speed four times, as we accelerate and de-accelerate on the compression and rebound direction. The shock shaft is just like a car passing through 50 mph on its way to 100 mph and then passing back through 100 mph as it brakes to a stop. If we are going to graph all this collected data we will have two lines on the compression side and two lines on the rebound side of the graph, one as we speed up to 10ips and one as we slow down.

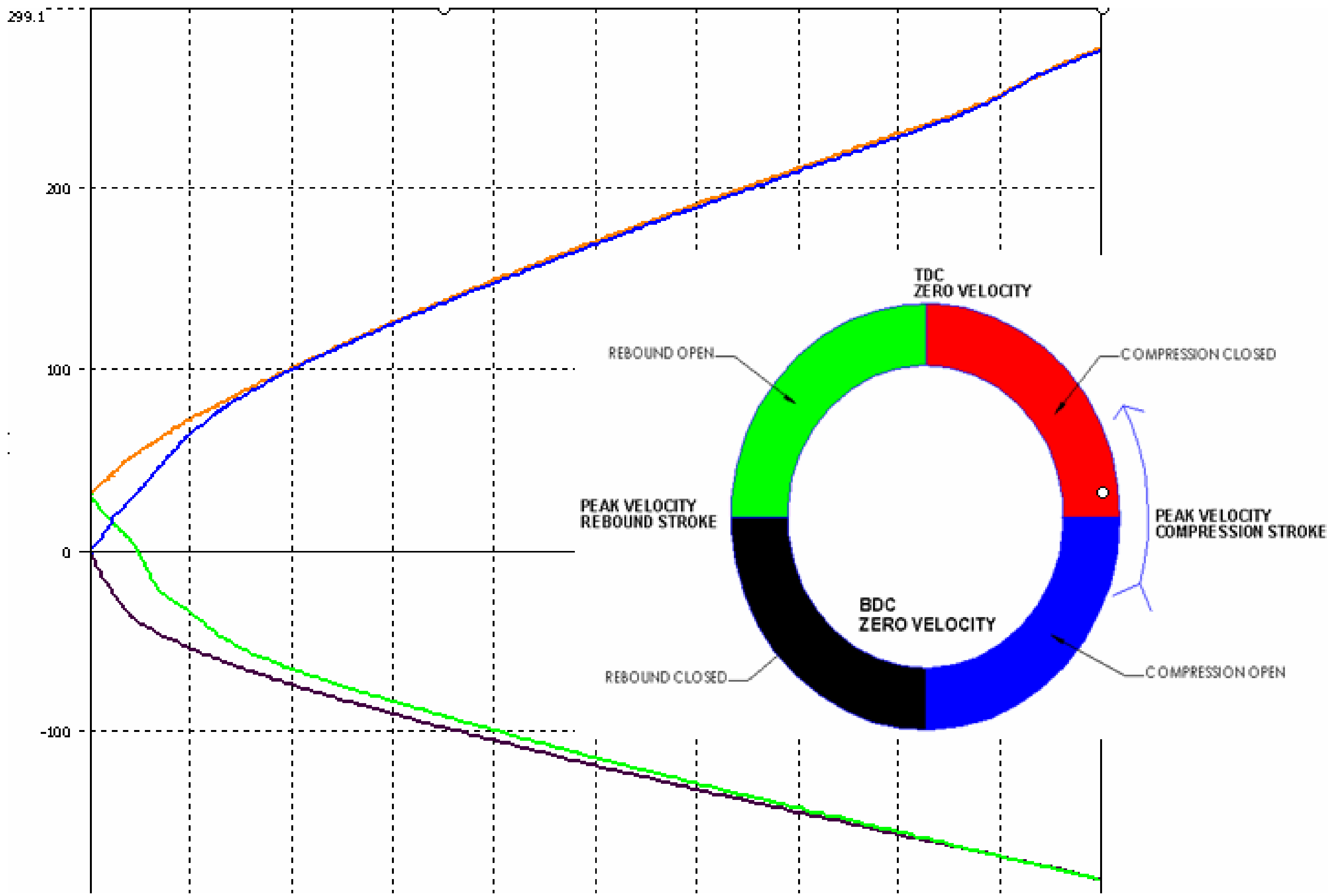
To make this easier to keep track of we have broken one cycle of the crank down into four quarters. Compression open, compression close, rebound open and rebound close.

The following picture color codes the position on the crank with the data on the graph. (force above the zero line is compression force, below the zero line is rebound.)

BLUE – This is the compression open quarter. The crank moves from BDC to 90 degrees. The shock shaft is accelerated from zero velocity to the peak speed at 90 degrees. We can see the blue line on the graph extending from 0 velocities (this is BDC on the crank) to 10ips velocity. Also note the force increases as the velocity increases.
RED – This is compression close. The shaft must slow down to return to zero velocity at TDC. Note the red line on the graph that starts at 10ips and returns to zero velocity (TDC on the crank)

GREEN – We now have changed direction and started into rebound. This quarter is rebound open and we are accelerating to the peak velocity in the rebound direction.

BLACK – rebound close is the quarter we slow in the rebound direction returning to BDC and completing one cycle.


299.1
200
100
0
-100
TDC
ZERO VELOCITY
REBOUND OPEN
COMPRESSION CLOSED
PEAK VELOCITY
REBOUND STROKE
PEAK VELOCITY
COMPRESSION STROKE
BDC
ZERO VELOCITY
REBOUND CLOSED
COMPRESSION OPEN

The next thing we need to understand when discussing is how a crank type shock dyno can produce different velocities at the shock shaft when the crank is turning at a constant RPM. Figure one shows a simple crank dyno. At TDC (top dead center) and BDC (bottom dead center) the velocity of the shock shaft is zero, the shaft must stop before it can change direction (from compression to rebound at TDC and rebound to compression at BDC).

If you picture two people throwing a baseball back and forth no matter how fast the throw the ball the ball still must come to a complete stop as each person catches and then throws the ball.

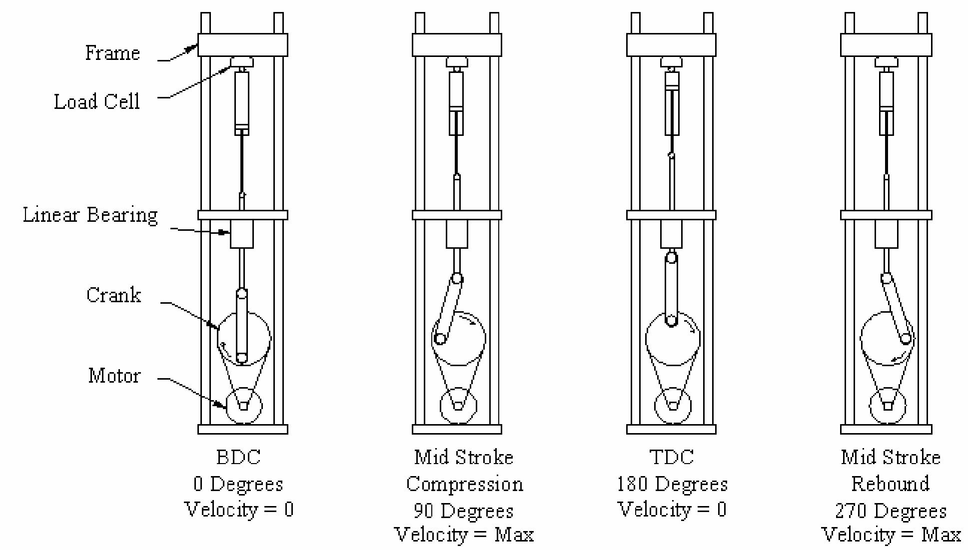
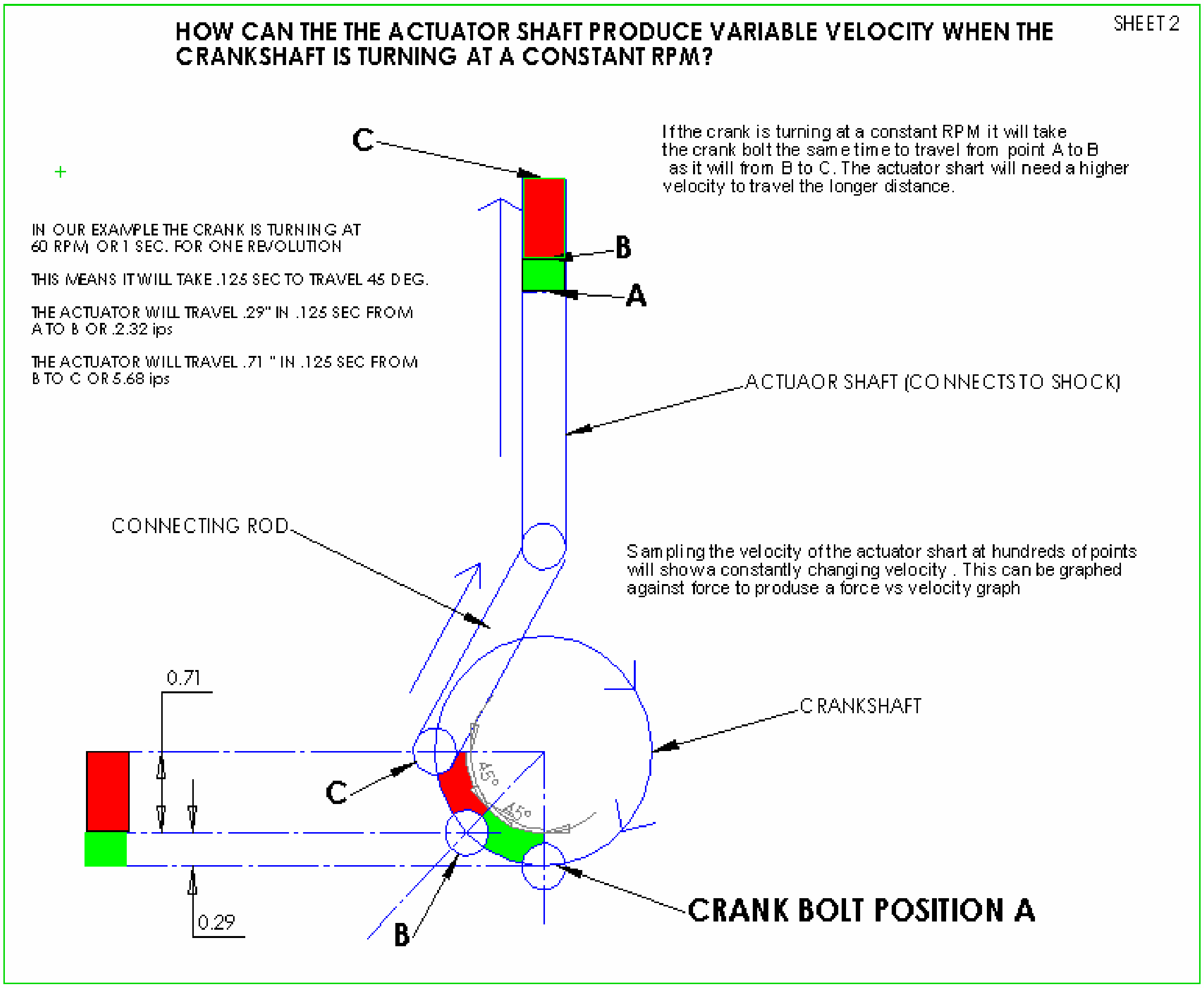


Figure 1

The other two pictures of our simple crank dyno shows the crank at mid stroke. At this point the shock shaft would be at peak velocity, so we have a peak velocity point in the compression and rebound direction. We know that the shock shaft can not go from zero velocity at TDC to peak velocity at mid stroke and back to zero velocity at BDC without accelerating and de-accelerating.

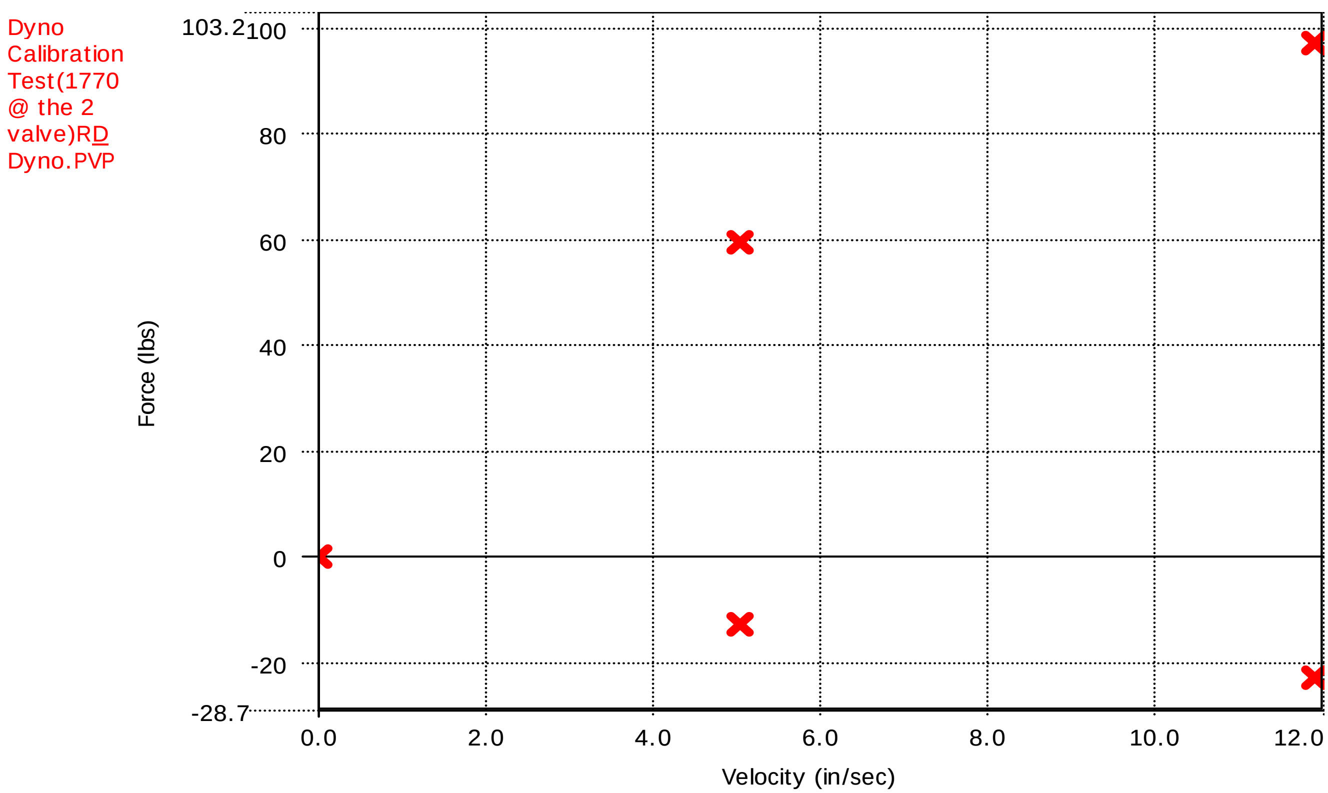
The speed of the shock shaft connected to the crank varies continuously as the crank rotates. You might remember from high school math or physics that this type of motion is called sinusoidal because it varies with the sine of the crank angle. The shock shaft comes to a stop at bottom dead center (BDC), accelerates to a maximum speed halfway up the cylinder, and slows down to a stop again at the top (TDC). The force generated also varies continuously. We have seen the maximum speed of the shaft happens twice per stroke, when the shaft is halfway between top and bottom, and that's also when the damper generates maximum force.



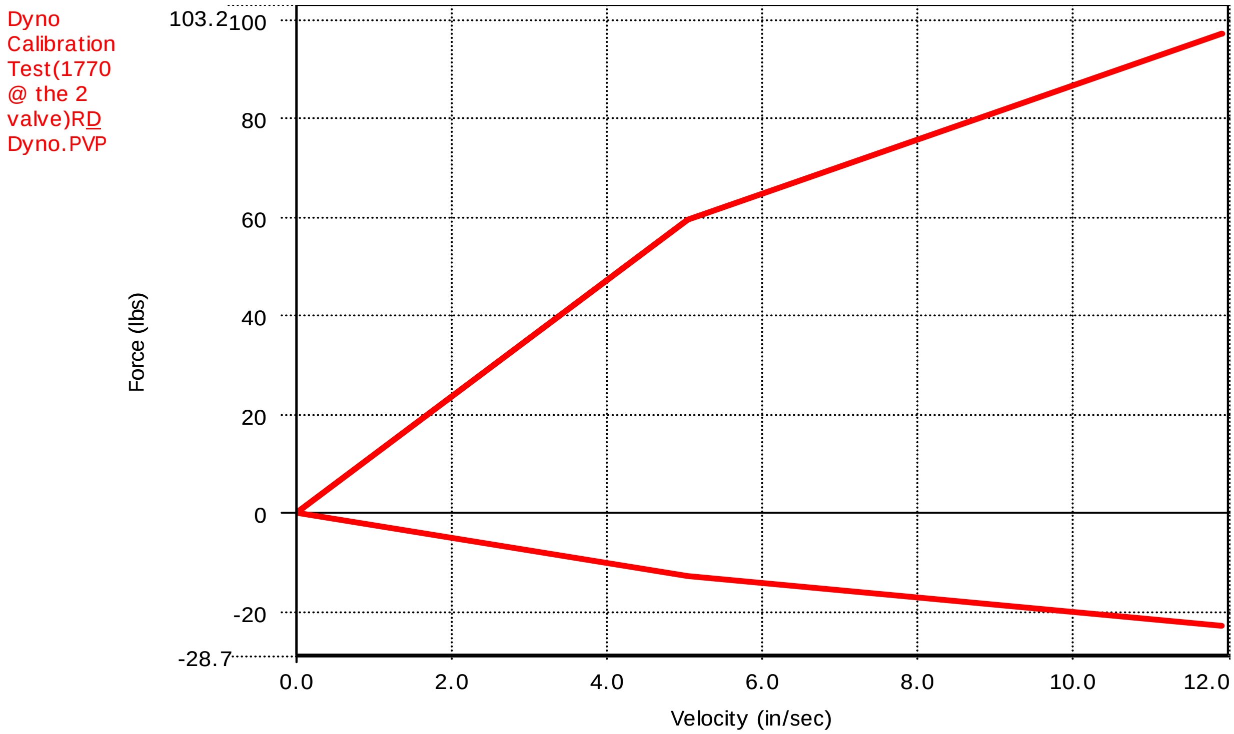
Now that we have a machine that can produce a constantly changing velocity, all we have to do is find some way to record this change along with the corresponding change in force produced by the shock and graph it. To accomplish the first part of this we use sensors, electronics and the data accusation board. The sensors (in this case a load cell to measure force and a velocity sensor to measure velocity) produce a very small voltage depending on how hard the load cell is pushed or how fast the velocity sensor is moved. In the case of the load cell the harder you push the higher the voltage. This voltage signal is sent to the electronics which boost the signal to a higher voltage and then sends it to the data board. The data board's job is to change this analog voltage to a digital signal that the computer will understand. The software converts this digital signal to real numbers (pounds, inches per seconds) and plots this on a graph. This really becomes useful when it happens thousands of times a second. A Roehrig dyno's default sample rate is 8000 times per second, on a 4 channel system that is 2000 times per channel. This means 2000 time a second the system looks at the voltage output of the sensors and converts it to a force and velocity point on the graph. From this we can produce a graph for a complete revolution the crank of one complete cycle of the shock.

PVP TEST

When we do a PVP test we only collect data at the peak velocity for each speed. We do this once in the compression and once in the rebound direction. We then increase the dynos speed and record at the peak velocities for that speed. We may do this for any numbers of speeds but at each speed we only collect two data points.

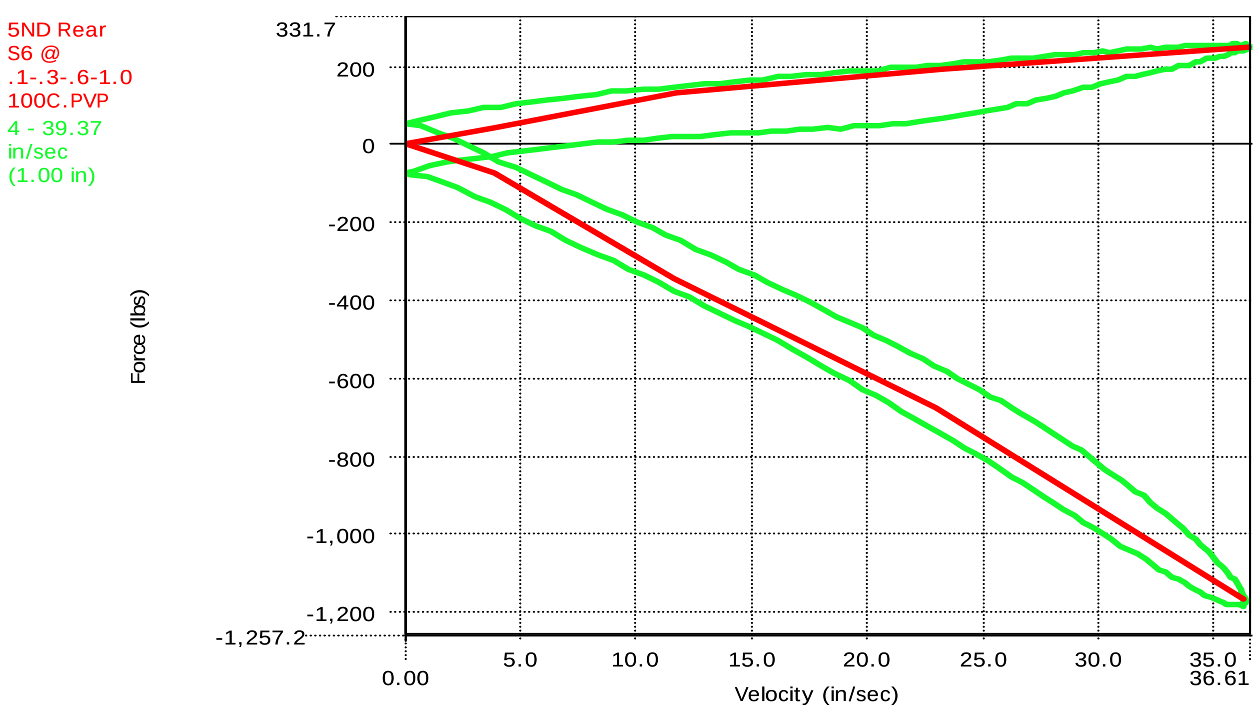


The graph above shows a two speed PVP test. The dynos ran at 5ips (inches per second) and 12 ips. At both speeds the data system recorded the force at the peak velocity in the compression and rebound direction and put a dot on the paper at these forces. The next graph shows what the trace looks like after the software connects the dots.

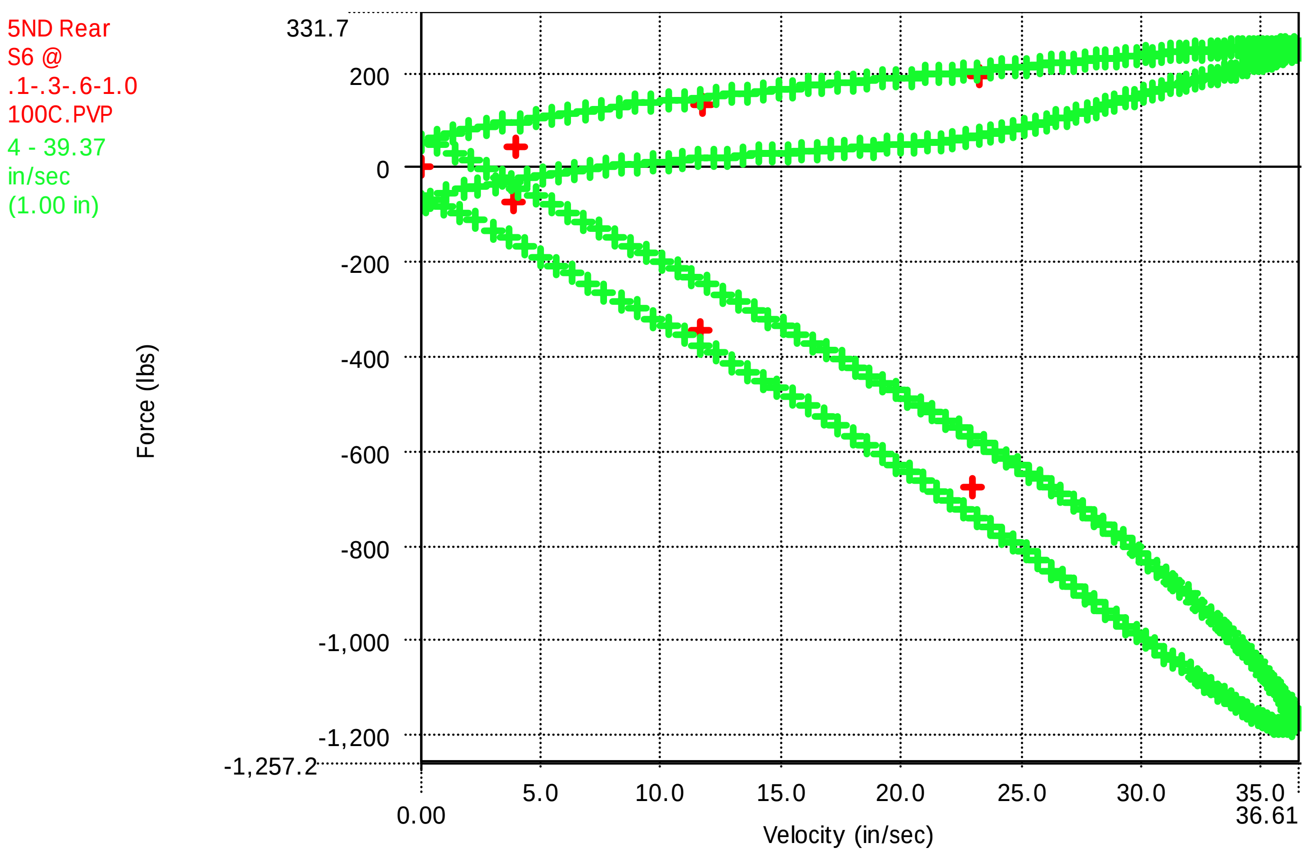


If we run more speeds we can collect more data but what we really need is some way to collect data over the complete cycle not just at the peaks. We need a continuous collection or CVP graph.

The CVP graph.-The CVP test does just what we talked about earlier. It collects 2000 samples per second and puts all those points on the graph.



The graph below shows the data points for the PVP graph in red and the CVP in green before the dots are connected by the software. As you can see we get a lot more points in a CVP than this 4 speed PVP.



THE END