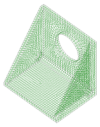
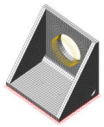
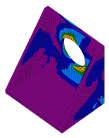

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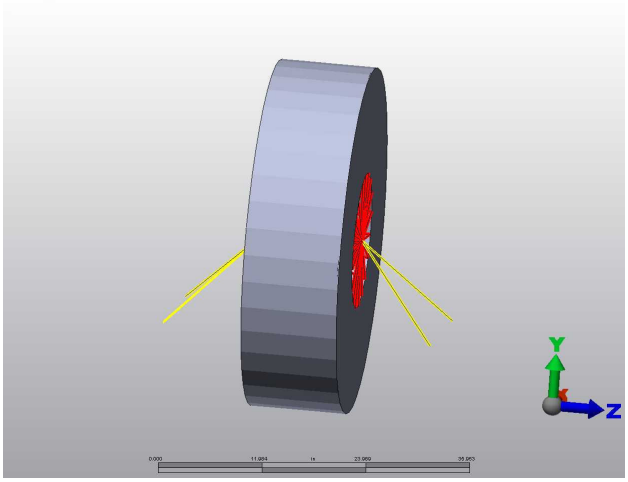
Study on Balanced vs. Unbalanced Truck Tire-Wheel Assemblies

For Centramatic, Inc. Alvarado, Texas

Given: Centramatic manufactures dynamic wheel balancers for truck tires. An eight ounce out of balance condition is to be studied.

Required: A truck tire/wheel combination should require more energy to move down the road if it is out of balance than if it is balanced. Quantify the difference in energy between balanced and unbalanced.

Solution: We constructed two FEA models of a wheel with a tire mounted to it. One had a fully symmetrical wheel and tire and the other added an 8 ounce weight to the rim of the wheel. Further we created a test stand on which to rotate the assembly. The stand was made of known member sizes and was sized so as to deflect when the wheel rotated. The resulting graph of the vertical position of the hub is used to compare the energy. Since all things in the two models were equal excepting the out of balance weight, we could compare the two to find the difference in energy.



The stand consists of the yellow struts supporting the hub. The bottom of the struts are fixed to the ground. The wheel is given an initial velocity equal to 55 mph. The vertical position, or y, is plotted as time goes on.

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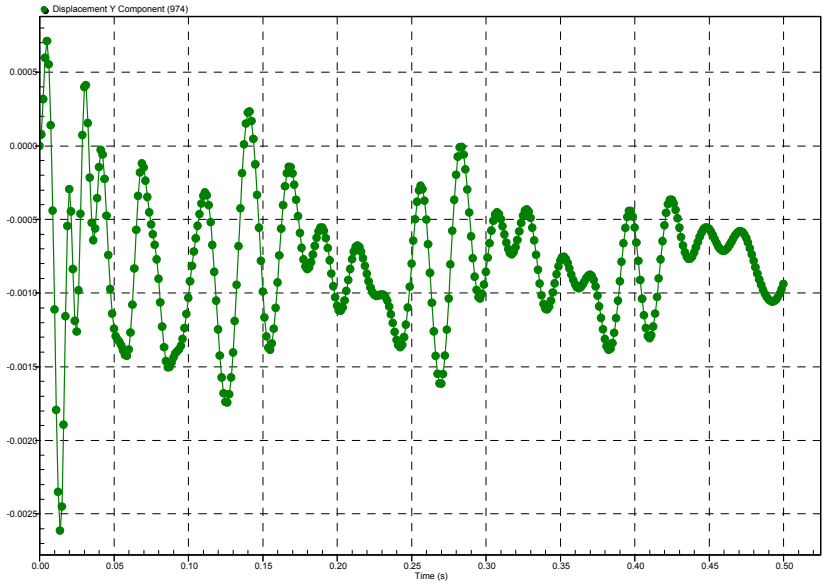
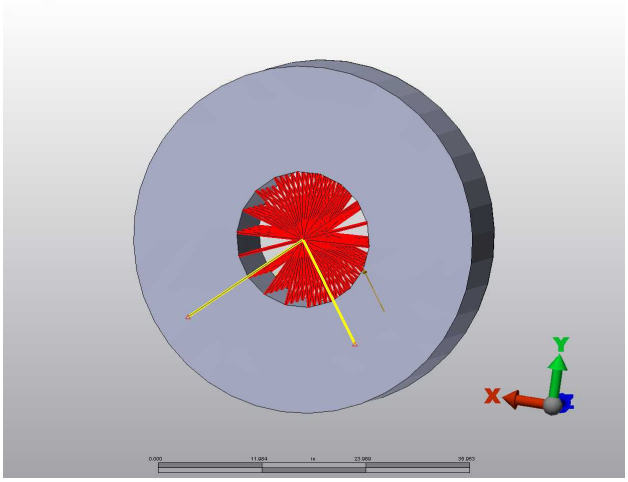


This graph shows the position of the center of the hub while the wheel is spinning. Note there is a small amount of variation in position. Also note that due to gravity, the position is almost all negative. This graph is shown for only ½ second which allows for 3.58 revolutions of a 43 inch tire.



Note small brown arrow at about 4 O'clock position. There is one of these on each side and shows where a mass of 8 ounces has been placed on the wheel rim to cause an out of balance condition. We will rotate this model at the same 430 rpm that the balanced model was spun.

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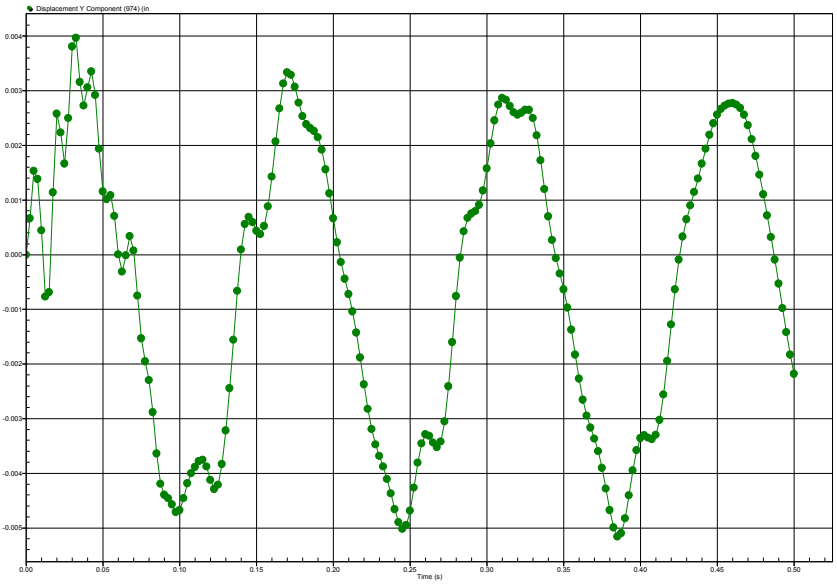

This graph is of the same time period, but you will notice that the magnitude of the position does not decrease and in fact stays rather constant. Another interesting fact is that the hub is actually getting a positive displacement meaning that the assembly is moving up.

Moving all data into a spreadsheet for comparison produces the next plot.

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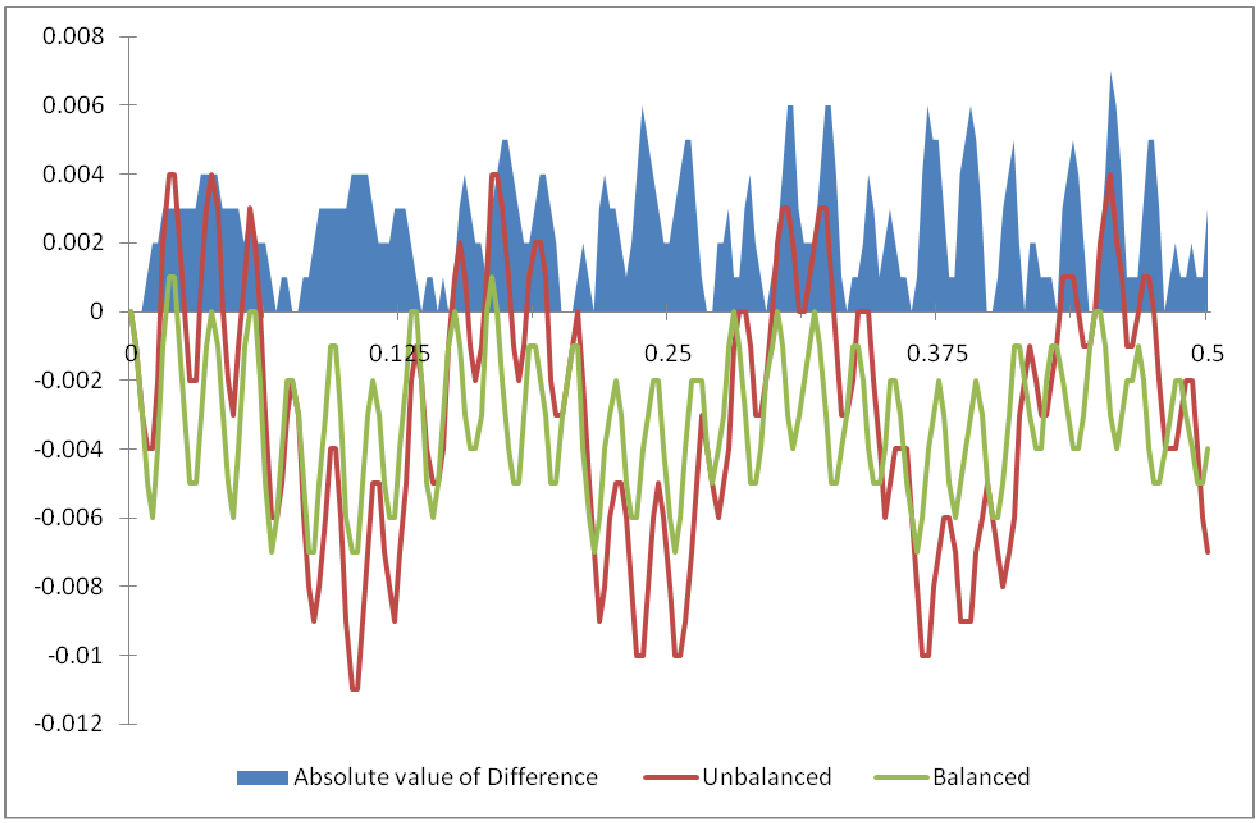

Comparing the balanced and unbalanced shows how the magnitude is increased with the unbalanced assembly. The difference between the two is plotted as the blue area and represents the difference in displacement of the test stand. Because the test stands were identical and because we know the spring rate of the test stand, we can calculate the difference in energy over the time of the test. We calculated that 0.0015 hp was expended during this ½ second test. Multiplying that out for one hour equates to 10.8 hp expended every hour. Another calculation gives the centripital force of an 8 ounce weight at 55 mph on a 43 inch tire is a whopping 252 pounds. That is a significant amount of weight to sling around.

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