IDENTIFYING LOAD MAGNITUDE AND LOAD POSITION INFLUENCES ON ROAD VEHICLE WHEEL ALIGNMENT VARIABILITY

by

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ABSTRACT

JUTTENBIR SINGH TATLA. Identifying Load Magnitude and Load Position Influences on Road Vehicle Wheel Alignment Variability (Under the direction of DR. PETER TKACIK)

A vehicle's suspension can experience slight variations in geometry due to a myriad of different conditions. The fluidity of a vehicle's suspension has led to the experimentation of what causes wheel alignment variability and how those changes affect variability. This study focuses on how load positioning and load magnitude affect standard deviation of camber, caster, and toe measurements. The vehicle chosen for this study is a 1999 Porsche Carrera 911 (996). Due to the nature of studying standard deviation, a large number of wheel alignment measurements were necessary; a new system was created for lifting the car and conducting wheel alignments. This was comprised of a four-post lift, custom crossbeams, and a custom inner stand. In regards to the experiment, each case, not including the base case, had load added in separate locations (front trunk, left side, right side, and rear) of the vehicle from 150 lbs. to 600 lbs. For each case, individual wheel loads were measured. Initial results showed that camber and toe variability increased with increasing wheel load. Under further investigation, neither wheel load magnitude nor load position influences wheel alignment variability. However, suspension geometry does influence wheel alignment variability. Multi-link suspensions are more susceptible to higher levels of wheel alignment variability than MacPherson strut suspensions.

ACKNOWLEDGEMENTS

This would not have been possible without a number of honorable mentions. This thesis is derived from an experiment conducted by two people. The second person from this experiment is Sagar Paradkar. Sagar spent countless hours with me loading and unloading the car, operating the alignment rig, and conducting wheel alignments. Sagar also helped during fabrication of the alignment stand. I would also like to thank Mitesh Shetty and Nazarii Olkhovskyi. Both were present during fabrication and initial testing of the four-post from my Tire Mechanics graduate project. Thirdly, I would like to say thank you to Mason Marino. Once everything was cut and prepped, Mason welded our alignment stand together. A special thanks is also given to Marion Cantor. Marion helped Sagar and me with the purchase order and coordinating pickup of necessary materials. I also want to give a thank you to Luke Woroniecki. There was a technical failure with the four-post and Luke was able to retrieve the test vehicle safely. I would like to give a final thank you to my research advisor, Dr. Tkacik. He was very helpful in providing advice when I had any concerns in regards to the thesis. Dr. Tkacik also gave us permission to use the four-post, the Hunter Alignment system, and the Intercomp wheel scales. He was very generous and allowed us to use his personal Porsche Carrera 911 as the test vehicle.

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LF	Left Front
RF	Right Front
LR	Left Rear
RR	Right Rear
IQR	Interquartile Range

CHAPTER 1: INTRODUCTION

1.1 Project Origin

Wheel alignment is a necessary procedure which helps to ensure proper ride quality, vehicle performance, and proper tire wear. A wheel alignment consists of measuring and altering a vehicle's suspension geometry about camber, caster, and toe. In order to understand what these geometry variables are, one has to be familiar with the SAE tire coordinate system (shown in Figure 1). Within the SAE tire coordinate system, "x" refers to the longitudinal axis, "y" refers to the lateral axis, and "z" refers to the vertical axis (X-Engineer). In this perspective, the tire rolls along the longitudinal axis. Camber is defined as the angle of inclination about the longitudinal axis where inward inclination is negative and outward inclination is positive. Caster is defined as the angle of inclination of a vehicle's steering apparatus about the lateral axis. A positive value

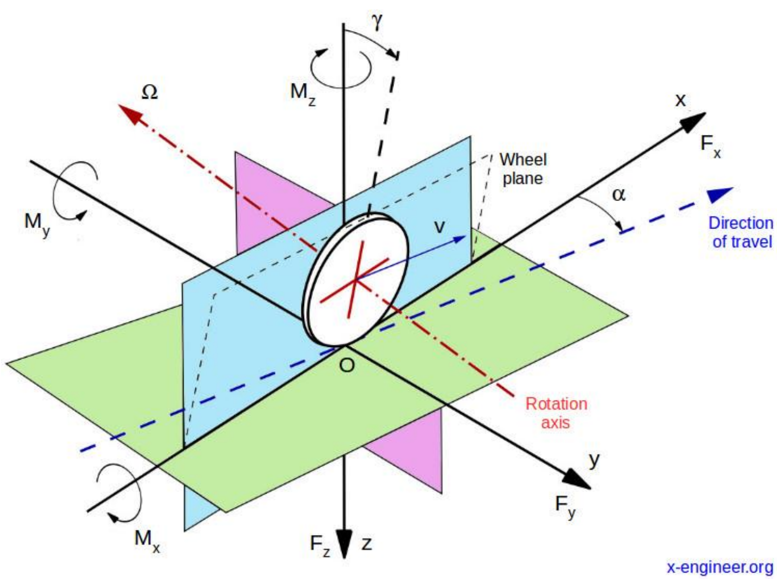


Figure 1: SAE Tire Coordinate System (X-Engineer)

refers to inclination towards the middle of a vehicle and a negative value refers to inclination towards the front of a vehicle (assuming steering is only in the front). Toe is defined as the inclination about the vertical axis where inward tilt is positive (toe-in) and outward tilt is negative (toe-out). It is well known that these suspension variables are susceptible to changes in alignment if a vehicle has warped steering knuckles, worn suspension components (bushings, ball joints, springs, etc.), or if a vehicle encounters an obstacle such as a pothole or a speedbump. While variations do occur on the road, these are still detected in between alignment measurements. Even though a wheel alignment measurement produces values with incredible precision, minor alignment changes are often seen with subsequent independent measurements. Because of this phenomenon, researchers have begun to study what variables influence wheel alignment variability. Variables of interest in past studies have included suspension stiffness, tire pressure, wedge influence, and time influence including others (Patel, H.). This study focuses on load magnitude and load positioning influence of vehicle wheel alignment variability.

The thesis statement for this study is as follows:

Discover if and, if applicable, how load magnitude and load positioning within a vehicle influence wheel alignment variability.

1.2 Interest in Kinematics & Compliance

K&C testing analyzes a vehicle's suspension through the measurement of suspension geometry (kinematics) and suspension stiffness (compliance). This type of testing is done at Morse Measurements of Salisbury, NC, using their Anthony Best K&C test rig. The Anthony Best K&C test rig is capable of a wide range of tests such as bounce, roll (fixed or natural axis), longitudinal compliance (braking and traction), lateral compliance as well as others. In order to conduct many of these tests, the K&C test rig clamps onto the chassis of the vehicle and transfers load to and from the individual wheels via moving the chassis. In the thesis experiment, load is only added on top of the vehicle which limits how the chassis can respond. The question is: How does K&C data compare to the wheel alignment data collected from this experiment? This question is the thesis topic for Sagar Paradkar, as he was the secondary person who conducted the wheel alignment experiment. For more details and analysis in regards to this question, please read Sagar's thesis paper (added in References).

Figure 2: Anthony Best K&C Test Rig

CHAPTER 2: ALIGNMENT PREPARATION

2.1 Important Alignment and Measurement Equipment

At UNCC Motorsports Research, Hunter alignment equipment is available for use. This consists of a Hunter PA130 computerized wheel alignment center, four DSP700 alignment heads, four alignment stands (one for each wheel), and four bearing plates. The PA130 is a console which contains the user interface for the operator. The DSP700 alignment heads connect directly to each wheel rim. Each alignment head collects measurements and communicates with the PA130.

Figure 3: Hunter PA 130 & Intercomp Scales

The alignment stands (Figure 4) are typically used in conjunction with a two-post lift. They allow a vehicle to rest on a completely level surface. Slip plates are integrated into the rear wheel stands to prevent the wheels from rolling. Additional wheel chocks are used for smaller wheels. Bearing plates (Figure 4) are used in order to allow for ease of rotational and translational movement for each wheel. These bearing plates discourage tire scrub each time the car is placed back down on the wheel stands. By avoiding tire scrub, preload within each wheel (which could cause alignment measurement inaccuracies) is also avoided.

Additional measurement equipment important for this experiment, and similar ones, is the Intercomp Wheel Scale System. This is comprised of four wheel scales, with a total capacity of 6000 lbs., and a control box.

2.2. Previous Wheel Alignment Lift Procedure Issues

Wheel alignments at UNCC Motorsports are traditionally conducted with the use of a two-post lift. A two post lift is able to lift a vehicle by positioning two swing arms, attached to each post, underneath the vehicle. The contact point on each swing arm is very small (roughly 3” by 6”) so positioning is critical when lifting a vehicle. The stage is set when a vehicle is lifted onto the bearing plates (which rest on top of the alignment stands), wheel chocks are in place, and the DSP700 heads are mounted and compensated. When a subsequent wheel alignment measurement needs to be conducted, an operator needs to ensure that the swing arm contacts are in the correct position. The vehicle is lifted off of the bearing plates, allowing the wheels to droop, and then it replaced onto the bearing plates.

Figure 4: Two-Post Lift Procedure (Patel, H.)

When this is done repeatedly for multiple alignment measurements, the vehicle tends to shift positions when placed back onto the bearing plates. Due to this, constant readjustment of the swing arms is necessary in order to ensure that the car is lifted off of the bearing plates safely. This also causes an issue of lowering the car accurately onto the bearing plates since the car has in fact shifted. A response to this has been to roll the vehicle back and forth while it remains on the bearing plates in order to reposition it for lifting. The problem with doing this is that it poses a risk of a wheel falling off of an alignment stand, especially when the car has shifted a considerable amount. This constant readjustment causes a significant delay in efficiency in regards to completing multiple alignment measurements including caster sweeps.

Since the experiment of this thesis requires a large number of independent alignment measurements, this procedure would not be optimal timewise. A new design and procedure is implemented in order to circumvent this issue.

2.3. Structural Design for New Procedure

In order to decrease time between independent alignment measurements including caster sweeps, it would be wise to use a different lifting apparatus than the two-post lift. The four-post lift is chosen for this experiment. Rather than lifting the car by the frame, a four-post lifts the entire car (wheels included). This means that the bearing plates must be placed along the four-post runways. To make for easier loading and unloading of a vehicle onto the four-post, wooden slabs are added to each runway so that the bearing plates sit flush.

It's important to note that this experiment uses only one vehicle. That vehicle is a 1999 Porsche Carrera 911. This means that all modifications and new structures must be built to fit this car. The wooden slabs, discussed earlier, are cut specifically to fit the wheel base of the Porsche. This means that the location of the bearing plates will fit that car, and that car only.

Figure 5: 1999 Porsche Carrera 911

The steps necessary before and after a traditional wheel alignment still need to be conducted. This means that the car still needs to be lifted from the frame in order to let the wheels droop. Since a lifting mechanism is already in place (the four-post), a set of structures are created to temporarily lift the car from the runways. In this case, a stationary object “lifts” the car by its frame when the four-post is lowered beyond a certain height. These designs consist of three main parts: the alignment stand (not to be confused with the two-post alignment stands), the crossbeams, and the connection hardware.

The alignment stand is the main structure which lifts the frame of the vehicle. This is to sit in between the runways of the four-post. The stand is designed with a few features in mind. The main feature is to combat the small contact area issue of the two post lift. This issue is alleviated by having two contact points, each spanning 70 inches. This means that if the car does shift in between alignment measurements, significantly less re-adjustment is necessary. I’ll retouch on this feature in regards to the crossbeams.

Figure 6: Alignment Stand

A secondary goal of this stand is to keep it portable. The stand is made primarily of 2” x 4” x 0.25” steel rectangular tubing, 0.25” thick steel plates, and 0.135” thick steel bands, making it very heavy (331 lbs.). This makes it difficult to position the stand by hand. Square steel tubing (1” x 1” x 0.083”) is welded to the longer sides of the stand at a height of 3.5”. This height is chosen so that the stand can be lifted with a pallet jack.

A third goal is to keep the test area at a chest level height. This makes it easier to mount alignment heads and reposition the car if necessary. In order to do this, the stand is designed to meet a height of at least 50”. The stand is also equipped with improvised adjustable feet to ensure that the stand remains level when lifting the car. Grade 5 bolts (yield strength: 92,000 psi) and grade D nuts (load stress: 150,000 psi) are used for the feet to prevent any deformation.

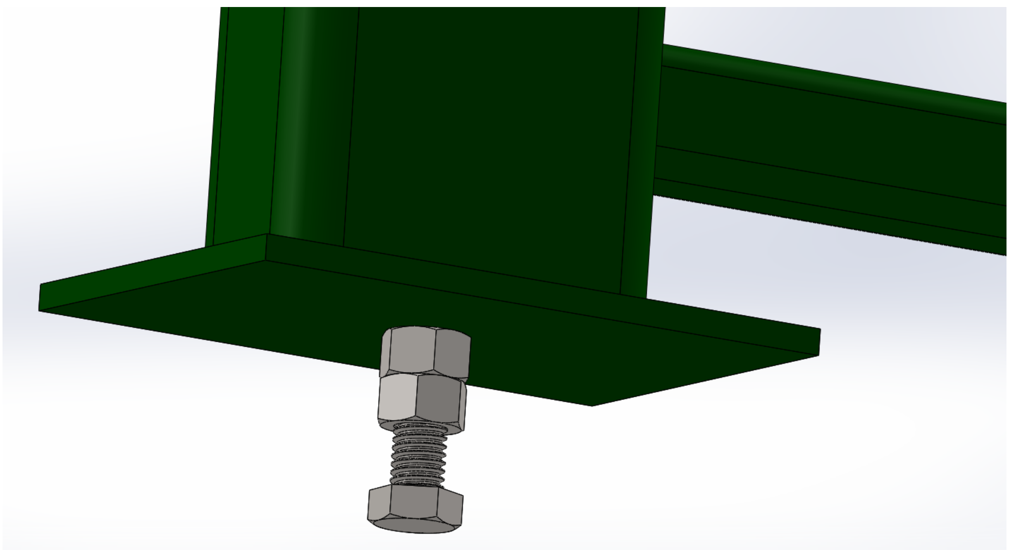


Figure 7: Alignment Stand Foot

Since the alignment stand sits in between the runways of the four-post, it sits right underneath the undertray of the Porsche. The undertray is a plastic cover that influences vehicle aerodynamics and also helps to protect the brake lines, the fuel lines, and the power steering lines of the Porsche 911 (996). This piece of plastic doesn’t offer any structural points where the car can be lifted. If the alignment stand were to contact this directly, lines would most likely break as well as the undertray. This issue is solved with the use of crossbeams. The crossbeams are designed to span the width of the Porsche. Jack-points are found just behind the front wheels and just ahead of the rear wheels. These are where the crossbeams are designed to mount. In this position, the crossbeams are 52” apart. When interacting with the alignment stand, a total of 18” of free space is still available along the alignment stand (9” front, 9” rear). If the vehicle does shift, contact points are continuous laterally because of the cross beams and 9” of leeway is available both in the rear and the front because of the size of the alignment stand. This provides a much larger lifting area than the two-post lift. Three 0.19” spacers are used in between each connection to give clearance between the undertray and the jack-points.

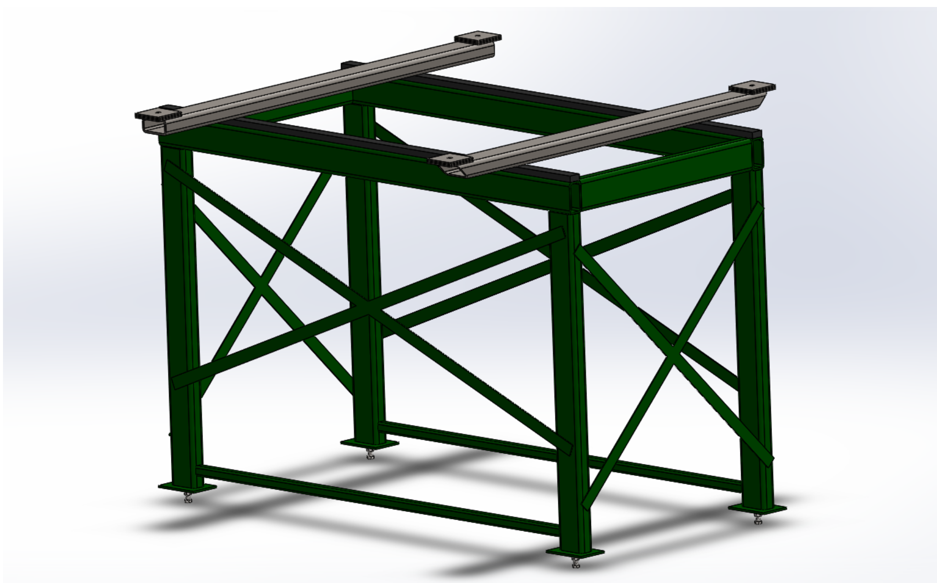


Figure 8: Crossbeam Position on Stand

As stated earlier, the crossbeams do mount to the underbody of the car. Luckily, the jack-points on the Porsche already had holes in them. This made it much easier to add the crossbeams. Similarly, holes are added to the crossbeams to help with mounting. The front jack-points have a 1”x 1.75” shelf which allows space for a fastener. For the front connection, a 0.125” slab is cut to fit inside that shelf and a nut is welded to that slab. Since a circular hole is already in the bottom of the jack-point, a simple bolt can be pushed through the crossbeam and then through the jack-point. The bolt would then meet the nut and slab placed inside the shelf. Figure 9 helps to demonstrate this method.

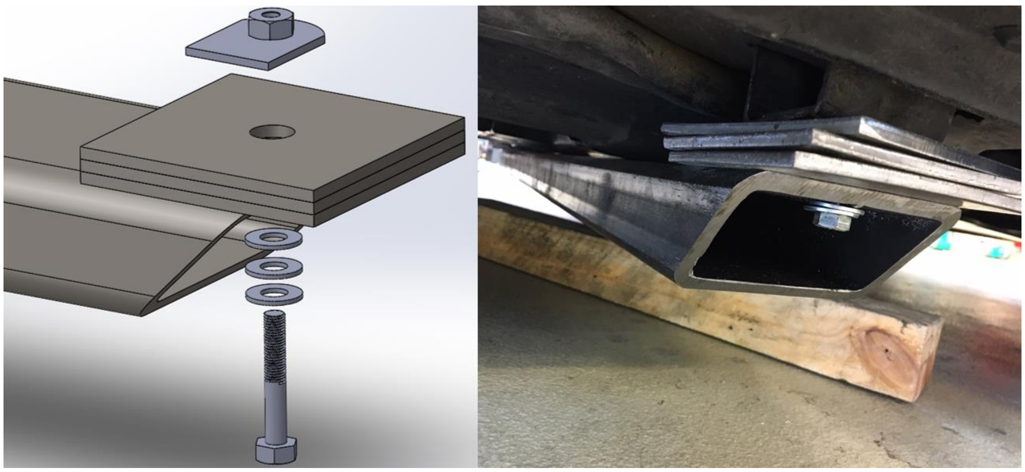


Figure 9: Front Crossbeam

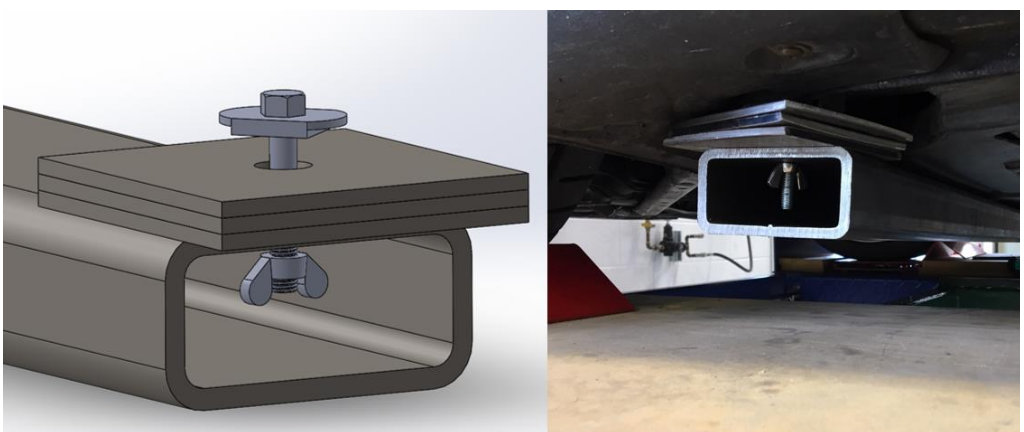


Figure 10: Rear Crossbeam

The rear jack-points do have a different shape than the front ones so a different design of hardware is necessary for the rear. There is no shelf on the rear jack-point. Also, the hole is oblong rather than circular. The connection designed for this is an inverted bolt (hex side upwards) welded to a piece of steel shaped to the oblong hole in the jack-point. The piece of steel welded to the bolt has a secondary layer which is shaped like a square. This

Figure 11: Rear Crossbeam Connection

connection works by inserting the bolt into the oblong hole. After the welded piece is fit beyond the oblong hole, the bolt is rotated 90 degrees and brought back downward. The square shaped layer prevents the bolt from rotating when it is flush with the hole. Once this is done, the rear crossbeam is carefully fitted and then fastened with a wingnut.

Figures 10 and 11 demonstrate this. Figure 12 shows all structures used together on the four-post lift.

Figure 12: New Alignment Structures

2.4. Operation of Entire Wheel Alignment Apparatus

Once the car is in the position shown in Figure 12, The Hunter DSP700s alignment heads can be mounted onto the wheels. Each alignment head is comprised of a sensor body and a toe arm. When mounting, the toe arm points towards the end of the vehicle (Figure 15).Two alignment heads have long toe arms while the other two have

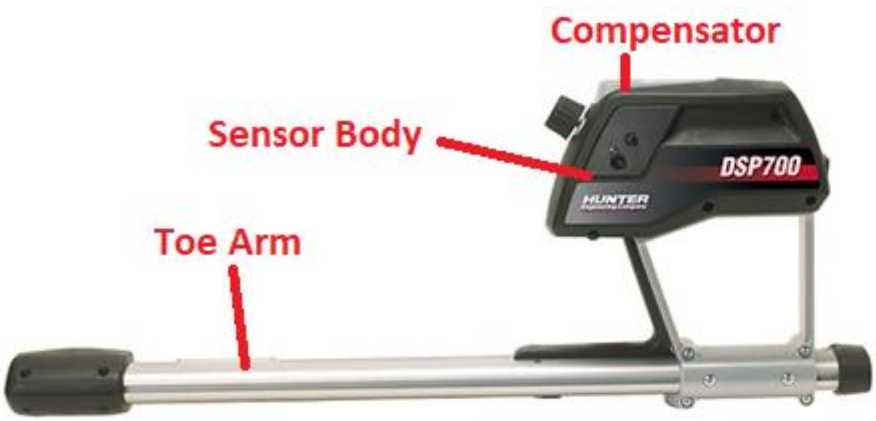


Figure 13: DSP700 Anatomy

short toe arms. The long toe arm heads are used for the LF and the RF while the short toe arm heads are used for the LR and the RR.

In order to mount each DSP700, a clamp is tightened around the outer rim of a wheel. It's important to add additional force to the top end and lower end of the clamp to ensure that the clamp is secured to the wheel. A safety hook is hooked to a wheel spoke for further security. Once all of the alignment heads are secure, they can now be compensated. The DSP700s use a 3-point compensation method. This is done by rotating a wheel clockwise in three 120 degree segments. Within each segment, the compensator button on the sensor body is clicked when all three lights (next to the compensator button) are litten up. The Hunter PA130 will verify which alignment heads are compensated (Figure 16) and which are not.

Figure 14: Securing Alignment Heads

Figure 15: Alignment Head Positioning

Along with setting up the DSP700 alignment heads, the PA130 must also be set up. On the PA130 main menu, a specific vehicle must be chosen. For each vehicle listed in the console, accepted alignment values are stored as well as instructions on how modify one’s suspension geometry about camber, caster, and toe. For this specific vehicle, the following selections are chosen in order: Porsche, 911, 1999-2005 Carrera (996), USA Models, Carrera, Carrera Sport. After all of these are chosen, the console measurements page is now visible (Figure 16). This displays camber, cross camber, toe, and total toe for both the front and rear. The front also displays caster and cross caster while the rear displays thrust angle. A green value represents an acceptable value while a red value is considered unacceptable.

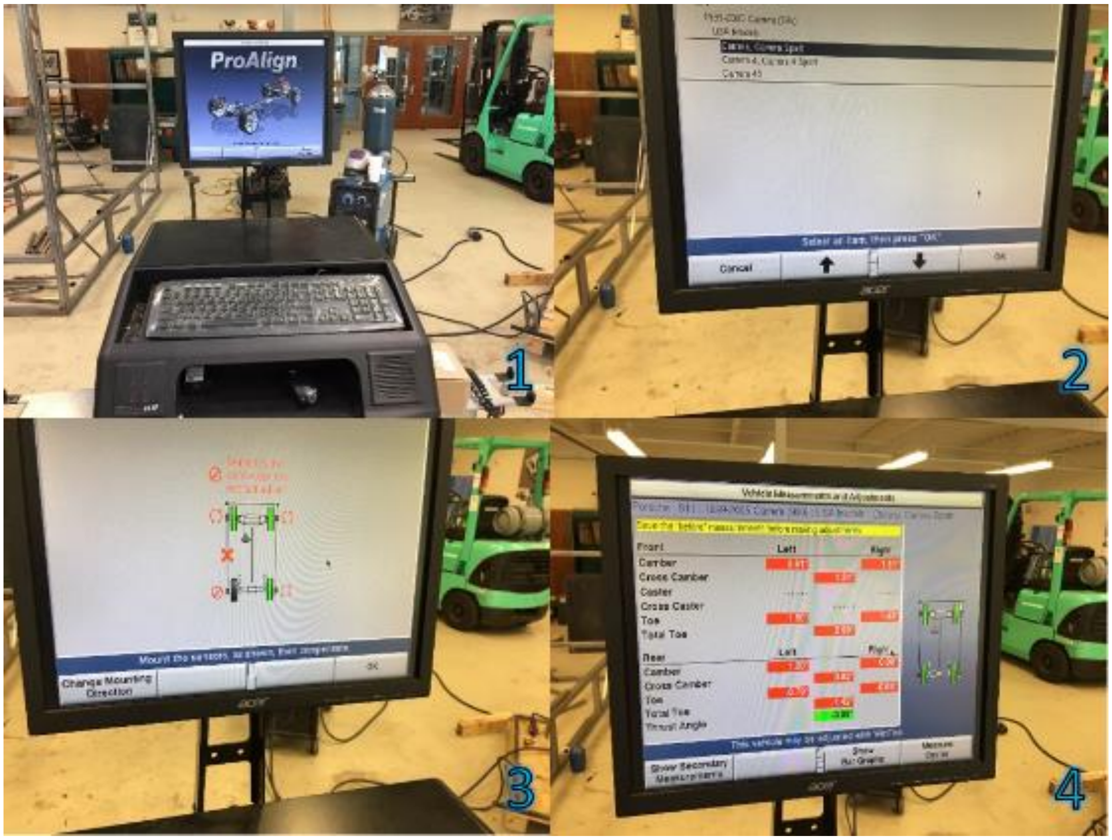


Figure 16: PA130 Screens – Main, Vehicle Select, Compensation, Measurement

Before alignment measurements are taken, the vehicle is weighed with the Intercomp scales. Each scale is labeled either LF, RF, LR, or RR so it's important to

Figure 17: Wheel Scales & Control Box

make sure that each scale is placed under the correct wheel. The scales are placed directly on the bearing plates. Before the four-post is moved, the handbrake must be on in the vehicle. This locks the rear wheels. If this is not done, the car will roll off of the wheel scales. Unfortunately this has happened before and it has the potential to cause damage to either the four-post or the car. Fortunately there was no damage when we did it. Individual wheel loads are measured 3 times for every 30 measurements (30 measurements is equivalent to 1 load case). This is done, rather than after every wheel alignment measurement because of time restrictions. In Figure 15, the car is resting on the alignment stand. In order to put the car onto the four-post, the four-post is hydraulically and cable lifted until it supports the full weight of the car. The crossbeams attached to the car should not be touching the alignment stand. Ensure that the runways are supported by the stopping wedges and not the cables. This acts as a safety in case the lift were to fail. This also acts as a level platform for taking measurements. The four-post is always lifted to the third stopping wedge to decrease potential variables. After this is done, the measurements are collected for each wheel from the control box.

Now that the Hunter alignment and Intercomp equipment procedures have been discussed, the operation of the alignment stand with the four-post can be discussed. Once the above setup (Figure 17) is complete with the alignment equipment minus the wheel scales, an alignment measurement including a caster sweep is performed (this specific procedure will be discussed in section 3.2). After this has been done, the vehicle's suspension must be reset. The runways are lifted off of the stopping wedges and then lowered to the point where the full weight of the vehicle is supported by the alignment stand (wheels drooped and off of four-post). Once this is done, the runways are lifted back to the third stopping wedge. The vehicle is then jounced in the front and rear. This centers the suspension.

Figure 18: Jouncing Front Suspension

A subsequent measurement can be taken after this. In regards to mount and dismount of the alignment stand, the runways are raised to the fifth stopping wedge to ensure clearance when placing/removing the stand. The stand can then be moved with the pallet jack.

2.5. Verification of Alignment Accuracy

In this experiment, the alignment measurements are conducted solely on the four-post lift. Before the experiment starts though, it's a good idea to make sure that the four-post lift produces similar results to the two-post lift in regards to accuracy.

One change was made to the four-post before comparison measurements were taken. During the Tire Mechanics graduate project (which consisted of fabrication and initial testing), Nazarii noticed that the Porsche would shift to the right every time the weight of the car would be transferred to the four-post. The car was taken off of the four-post and the bearing plates were measured with a digital level. Three of the bearing plates

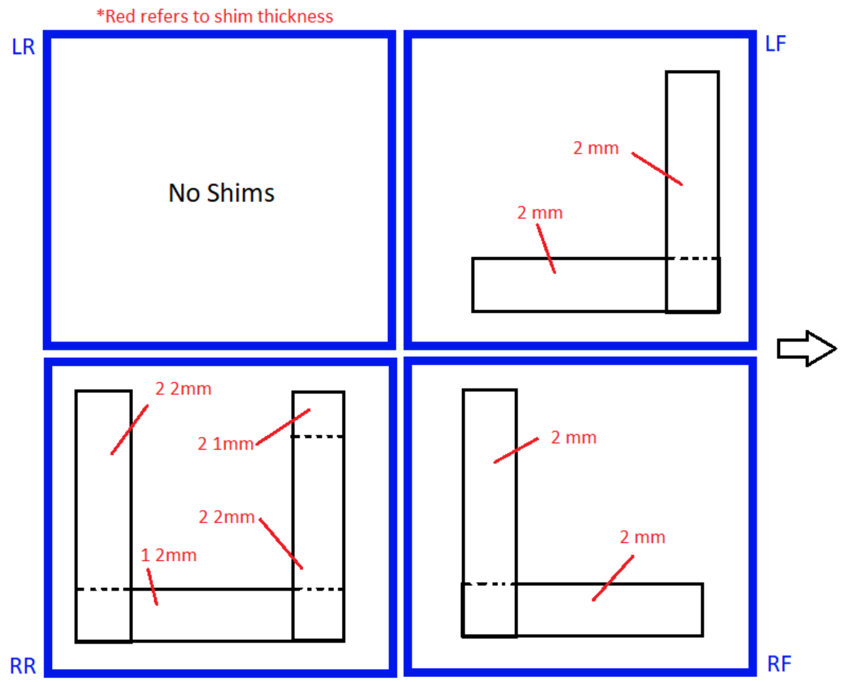


Figure 19: Shim Placement

were not level with each other and were also not leveled individually. To fix this issue, 13.5” long shims and a couple 3” long shims were placed underneath the LF, RF, and RR bearing plates. After trial and error, the bearing plates read out as level.

In 2015, the same group of researchers, who studied tire pressure influences among others for wheel alignment, also did a number of alignments on Dr. Tkacik’s Porsche 911. This was done with the use of the two-post lift. Out of all of the tests that were conducted, seven independent measurements were found which match the layout of my experiment which is the use of a constant driver weight and the use of un-bounded bearing plates (plates with the stopping rods removed). To keep this comparison balanced, only seven independent measurement results from my experiment are used to equal the amount of the previous group's results. Table 1 shows the collected data from the previous group's experiment on the two-post as well as the current experiment on the four-post. Standard deviations are taken for each set of measurements (e.g. LF Caster) and then compared in Figure 20. Standard deviation is used to measure the spread across each data set. The larger the standard deviation, the less accurate the data set is. By looking at Figure 20, five measurements are more accurate with the four-post (LF caster, LF toe, RF camber, RF toe, and RR toe) and five measurements are more accurate with the two-post (LF camber, RF caster, LR camber, LR toe, and RR camber). For further analysis, the factor of change per measurement category is calculated from each standard deviation (larger st. dev/ smaller st. dev). The values are then ranked from highest to lowest (Table 2) in an attempt to identify which system has a more significant change in accuracy. Neither the plot itself nor the ranking of factors point to a more accurate system. The average difference of standard deviation is 0.0176 of a degree which is fairly negligible. This concludes that accuracy is maintained with the four-post lift.

Table 1: 2-Post vs 4-Post Data Sets

2015 Group Results (2-Post) - 1999 Porsche Carerra 911										
	LF			RF			LR		RR	
Iteration	Camber	Caster	Toe	Camber	Caster	Toe	Camber	Toe	Camber	Toe
1	-0.18	7.96	0.01	-0.5	7.46	-0.07	-1.35	0.03	-1.36	0.19
2	-0.18	7.98	-0.03	-0.5	7.41	-0.03	-1.35	0.03	-1.36	0.18
3	-0.19	7.87	-0.03	-0.49	7.44	-0.04	-1.37	0.02	-1.35	0.16
4	-0.18	8.04	-0.04	-0.46	7.44	-0.02	-1.36	0.02	-1.36	0.16
5	-0.19	7.85	-0.04	-0.49	7.49	-0.02	-1.35	0.02	-1.36	0.16
6	-0.19	7.97	-0.02	-0.49	7.49	-0.04	-1.36	0.03	-1.37	-0.07
7	-0.19	7.84	-0.03	-0.49	7.53	-0.02	-1.36	0.02	-1.37	0.16
St. Dev.	0.004949	0.070912	0.015908	0.012454	0.037362	0.016782	0.006999	0.004949	0.006389	0.084152

Thesis Results (4-Post) - 1999 Porsche Carerra 911										
	LF			RF			LR		RR	
Iteration	Camber	Caster	Toe	Camber	Caster	Toe	Camber	Toe	Camber	Toe
1	-0.19	7.86	0.13	-0.35	7.67	0.13	-1.45	0.23	-1.55	0.16
2	-0.2	7.89	0.15	-0.34	7.65	0.11	-1.44	0.22	-1.55	0.17
3	-0.2	7.87	0.13	-0.34	7.71	0.12	-1.45	0.23	-1.59	0.16
4	-0.19	7.93	0.13	-0.36	7.62	0.13	-1.46	0.23	-1.57	0.18
5	-0.2	7.85	0.13	-0.35	7.56	0.13	-1.47	0.22	-1.57	0.18
6	-0.2	7.83	0.17	-0.36	7.62	0.1	-1.49	0.2	-1.57	0.18
7	-0.22	7.84	0.13	-0.35	7.67	0.13	-1.54	0.22	-1.55	0.17
St. Dev.	0.009258	0.031493	0.014569	0.007559	0.04463	0.011249	0.031816	0.009897	0.013997	0.00833

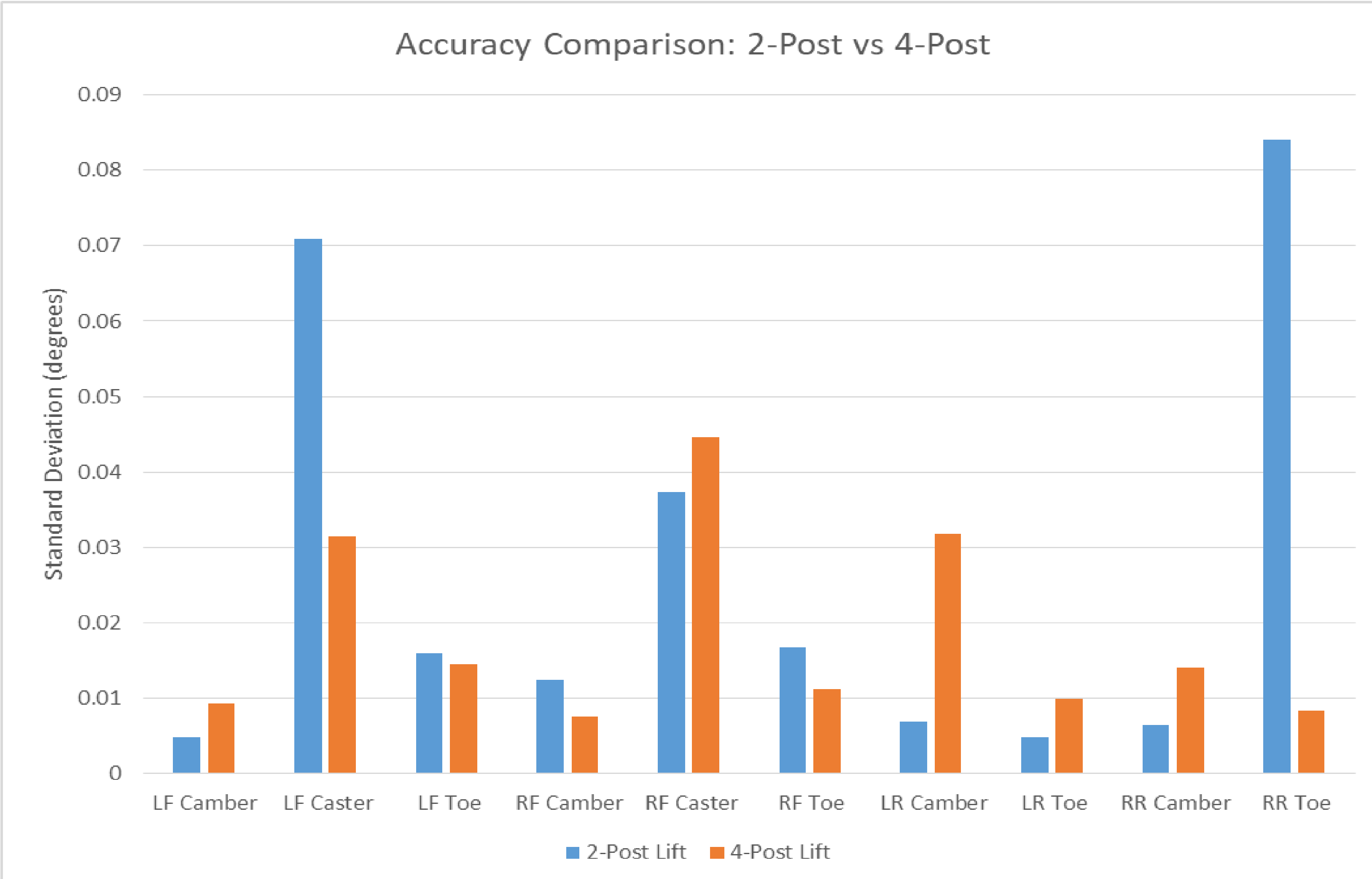


Figure 20: 2-Post vs 4-Post Data Accuracy

Table 2: 2-Post vs 4-Post Factor of Change

	Measurement	Factor of Change
Highest Factor of Change	RR Toe	10.10241672
	LR Camber	4.546060566
	LF Caster	2.251656912
	RR Camber	2.19089023
	LR Toe	2
	LF Camber	1.870828693
	RF Camber	1.647508942
	RF Toe	1.491913688
	RF Caster	1.194529441
Lowest Factor of Change	LF toe	1.091928428
* Color Represents the system with the higher St. Dev.		
Four-Post Lift		
Two-Post Lift		

2.6. Preparatory Measurements

During the Tire Mechanics course, my graduate project's goal was to complete fabrication of the alignment equipment and also to begin preparatory measurements in regards to experimentation. These preparatory measurements would serve the purpose of figuring out whether or not a thesis topic similar to this could produce meaningful results. My decision was to begin testing how load positioning would affect wheel alignment variability. In order to do this, load would be added to the seats of the Porsche in different cases (baseline, left load, right load, rear load, and front load). Due to budget, load was added in the form of people (group members). Below lists each case description.

- Baseline: 180 lb. driver only
- Left Load: 180 lb. driver with 130 lb. person in left passenger seat

- Right Load: 180 lb. driver with a person in right & rear seat, 180 & 130 respectively
- Rear Load: 180 lb. driver with one person in each rear seat, 130 (LR) and 160 (RR)
- Front Load: 180 lb. driver with 160 lb. person in front trunk.

Each load case was measured a total of ten times with the Hunter alignment equipment. Each load case was also measured once with the Intercomp wheel scales. Standard deviation was calculated about the ten measurements for each case and then plotted against wheel load. Position of the loads was also recorded within the plots. Figures 21, 22, and 23 show standard deviation versus wheel load for camber, caster, and toe respectively.

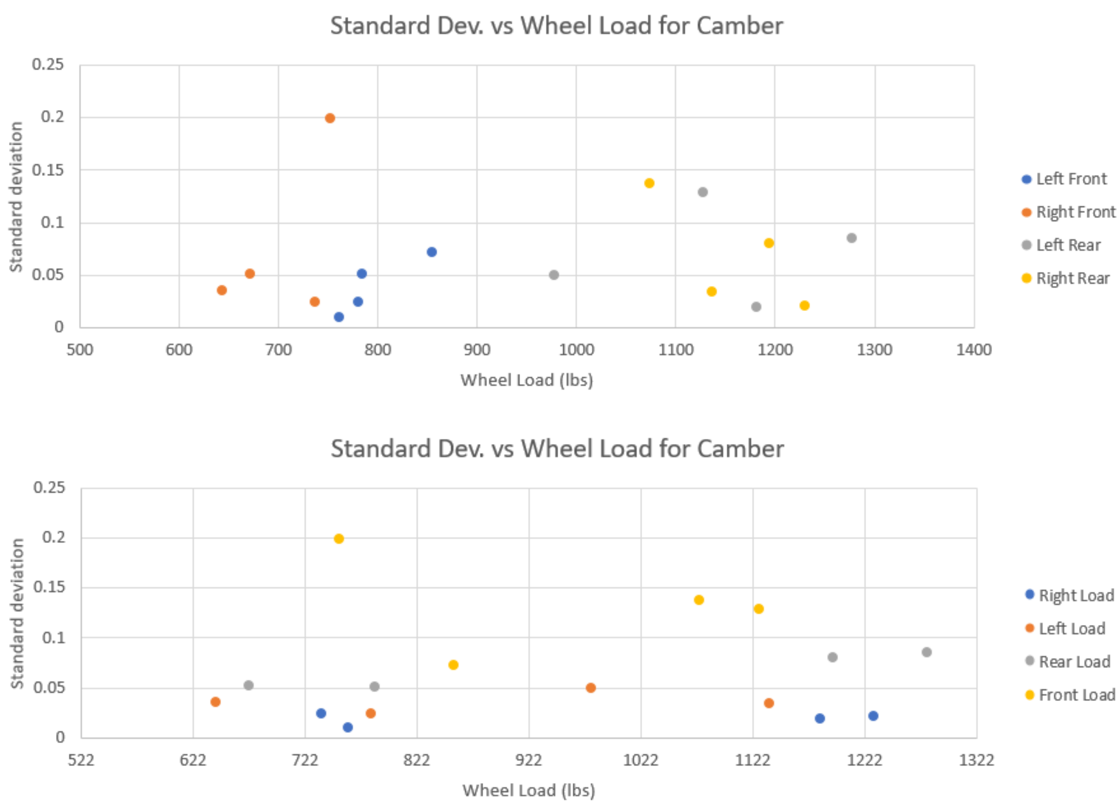


Figure 21: Preparatory Experiment – Camber Standard Deviation

As one can see, there are technically two plots for each figure (Figures 21 – 23). The purpose for doing this is to see which wheels experience the most variability in measurement (first plot) and also to see if there are any trends in regards to load positioning (second plot). Each plot (per measurement) displays the same information value wise, but the different legends help to display two different types of results.

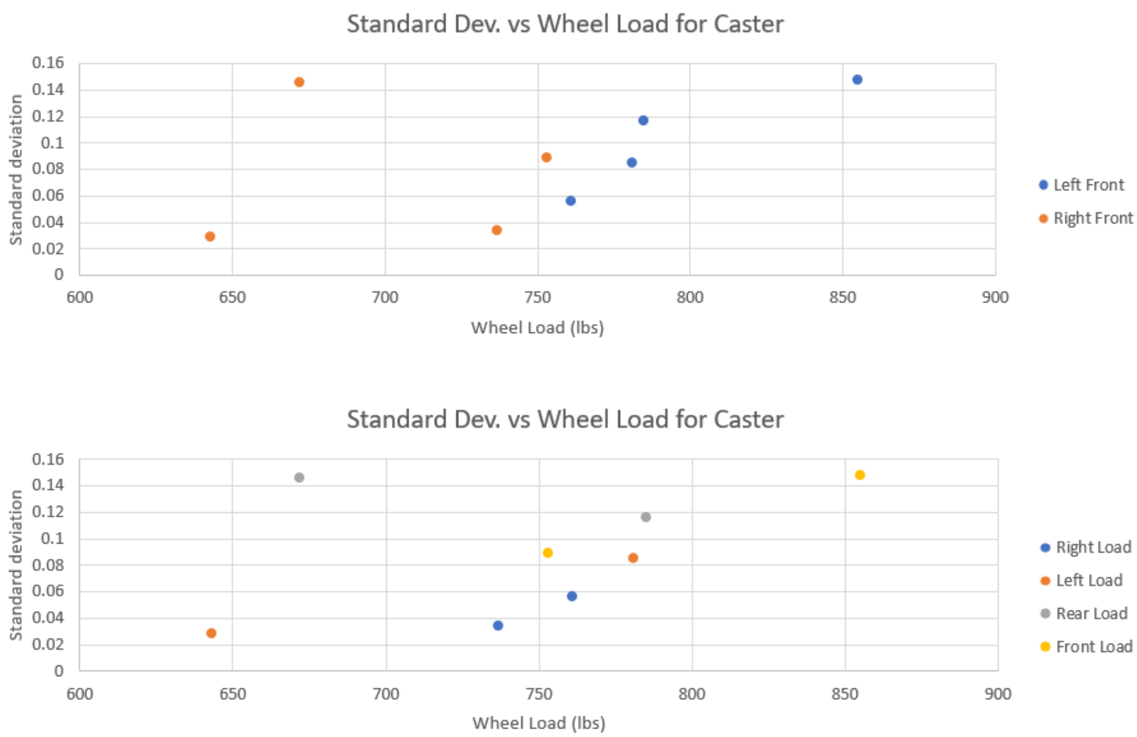
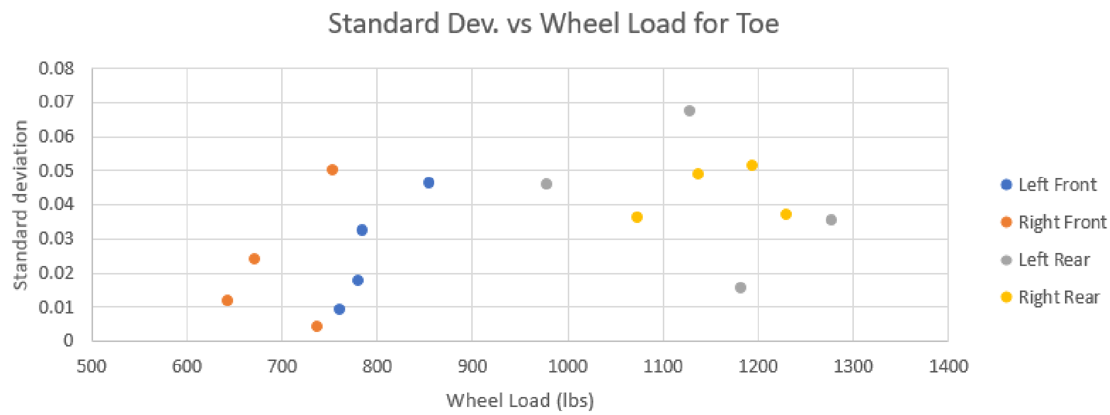


Figure 22: Preparatory Experiment – Caster Standard Deviation



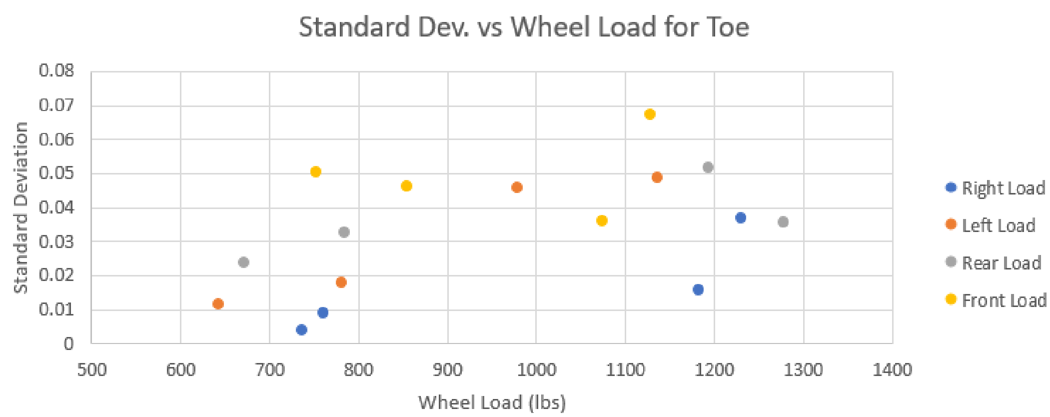


Figure 23: Preparatory Experiment – Toe Standard Deviation

The findings from Figures 21 – 23 are as follows.

Camber

- Assuming the fourth point is an anomaly, camber is more susceptible to variability as wheel load increases.
- The rear suspension is more susceptible to variability than the front suspension.
- Variability is lower when load is added laterally compared to load added in the longitudinal direction.

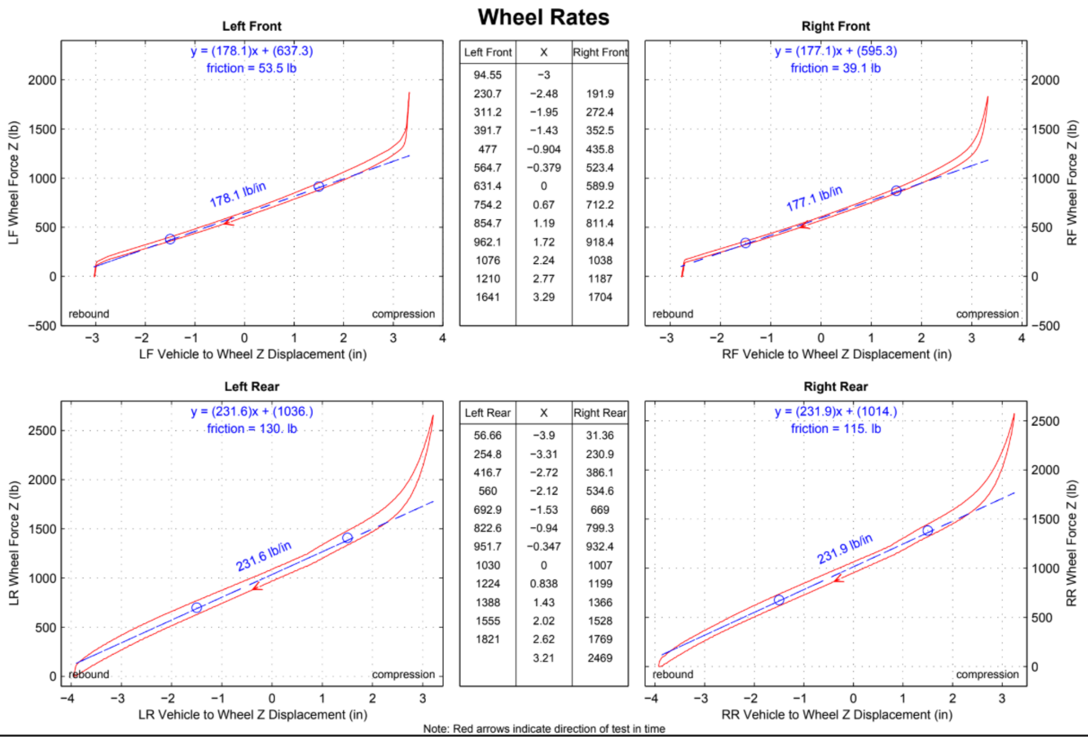
Caster

- Assuming the second point is an anomaly, caster is more susceptible to variability when wheel load increases.
- Variability is lower when load is added laterally compared to load added in the longitudinal direction.

Toe

- The rear suspension is more susceptible to variability than the front suspension.

The experiment also compared our results to K&C data taken at Morse Measurements. The tests done at Morse Measurements were also done on the same Porsche 911. I was able to compare our results to bump camber and bump steer curves. Both curves use measurement (camber or toe) vs wheel z-axis displacement. Since our experiments did not measure wheel z-axis displacement, superposition on wheel rate plots is used to calculate that value. Each wheel rate plot gives an equation for best fit



Left Front	X	Right Front
94.55	−3	
230.7	−2.48	191.9
311.2	−1.95	272.4
391.7	−1.43	352.5
477	−0.904	435.8
564.7	−0.379	523.4
631.4	0	589.9
754.2	0.67	712.2
854.7	1.19	811.4
962.1	1.72	918.4
1076	2.24	1038
1210	2.77	1187
1641	3.29	1704

Left Rear	X	Right Rear
56.66	−3.9	31.36
254.8	−3.31	230.9
416.7	−2.72	386.1
560	−2.12	534.6
692.9	−1.53	669
822.6	−0.94	799.3
951.7	−0.347	932.4
1030	0	1007
1224	0.838	1199
1388	1.43	1366
1555	2.02	1528
1821	2.62	1769
	3.21	2469

Figure 24: K&C Wheel Rate Plots

line of the curve displayed. Z-axis wheel force (measured from the Intercomp scales) is plugged into this equation to calculate a matching wheel z-axis displacement.

Similar to the wheel rate plots, Morse Measurements includes the best fit line equation for their bump camber and bump steer plots. Now that wheel z-axis displacement is calculated, I used our average measured camber and toe for each wheel to plot against the bump camber and bump steer fit lines. Figures 25 and 26 show those results.

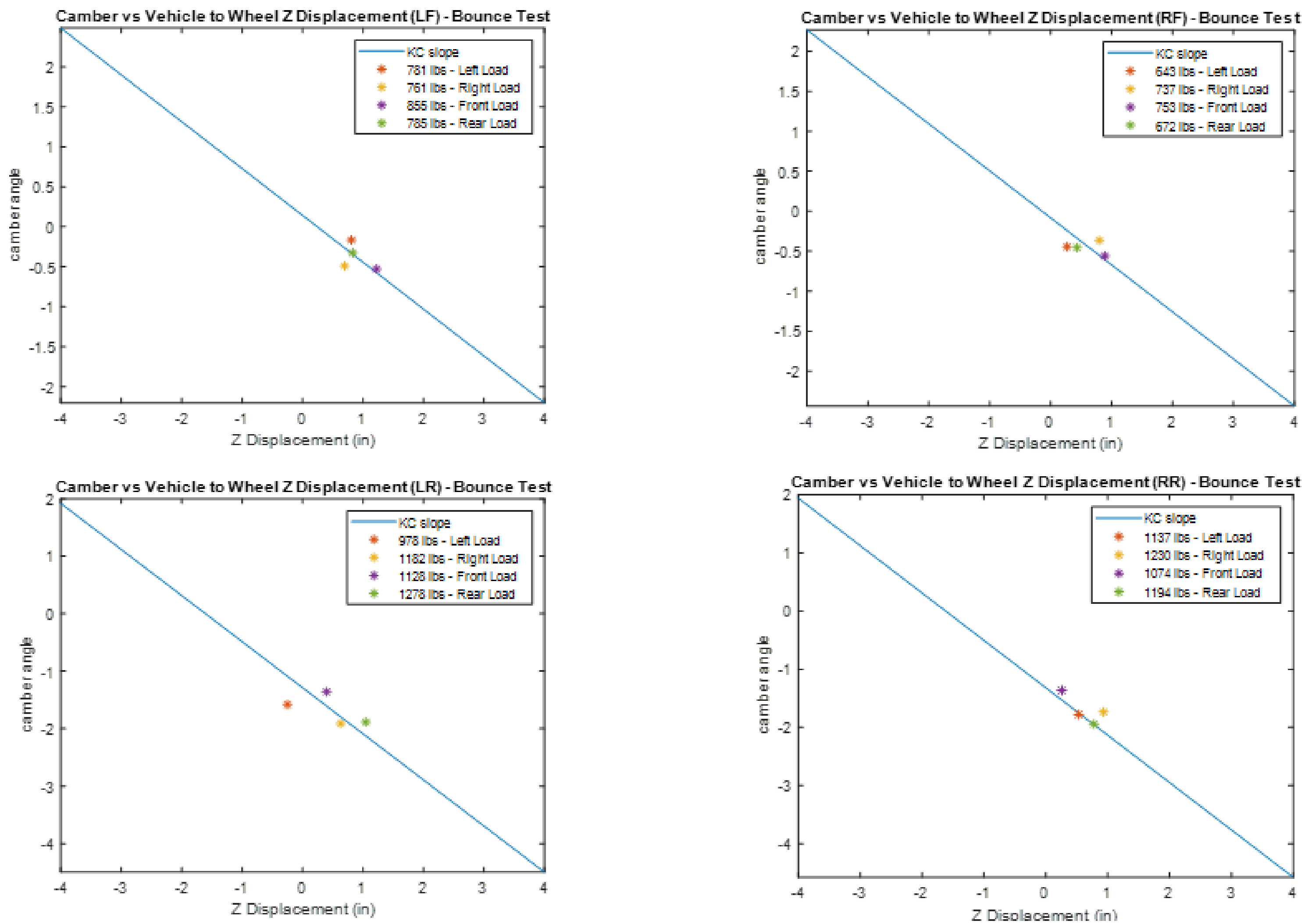


Figure 25: Preparatory Experiment - Camber Results vs Bump Camber

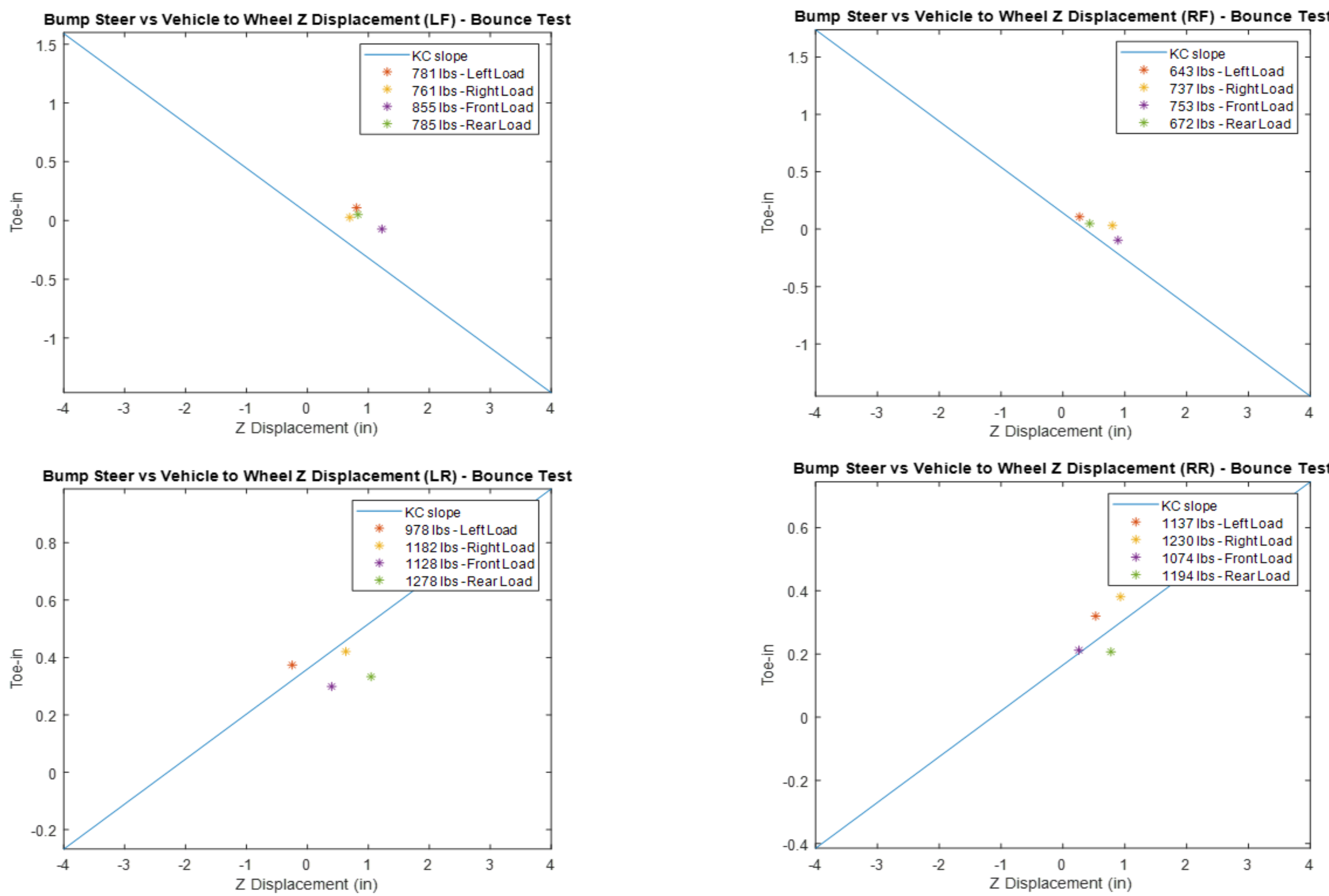


Figure 26: Preparatory Experiment - Toe Results vs Bump Steer

One can notice that the weight values for each measurement (camber and toe) match the fit lines fairly well. The values seem to match camber better than they do toe. It is also important to note that the individual weight values properly correlate to measurement values also. For example, LF camber shows a decrease in camber angle with increase in wheel load.

After this experiment analysis was finished, we noted that load needed to be better controlled. Rather than using people as additional weight, it would be much better to use inanimate weight as this would decrease human error and allow for better weight distribution. An example of human error would be the noticeable variability increase within all front load measurements. Since the front trunk was rather uncomfortable to sit in, I ended up fidgeting a lot during those measurements. We also agreed that an increase in measurements was necessary in order to decrease standard deviation. This would help to identify any anomalies within the data. The results shown from this experiment were mainly conclusive. Given this, Sagar and I tuned the experiment for our individual theses.

CHAPTER 3: TEST SETUP

3.1 Experimental Layout

The differences made in this experiment versus the preparatory experiment are that additional load is inanimate, a range of loads are tested for each load position, and significantly more measurements are taken. The type of load chosen for the experiment is in the form of sandbags. Sandbags were the most cost effective method of adding weight. 20 sandbags were purchased for a total weight of 1000 lbs. (50 lbs. per bag). To prevent sand from leaking onto the shop floor and into the car, each bag was double bagged with heavy trash bags. In order to put more focus into load magnitude than the preliminary experiment, load is ranged from 150 lbs. to 600 lbs. except for the front load case. The front load case maxes out at 500 lbs. The reason for a lesser amount is because we didn't want to risk damaging the front trunk and also additional space was very limited. Below lists the load position cases as well as the load magnitudes conducted for each position case.

- Base Case: 180 lb. driver only
- Left Case: additional 150 lbs., 300 lbs., 450 lbs., 600 lbs.
- Right Case: additional 150 lbs., 300 lbs., 450 lbs., 600 lbs.
- Front Case: additional 150 lbs., 300 lbs., 400 lbs., 500 lbs.
- Rear Case: additional 150 lbs., 300 lbs., 450 lbs., 600 lbs.

One side note is that each case includes a 180 lb. driver. Since both Sagar and I played the role of "driver" when taking measurements, an additional 20 lbs. of steel was added to the driver foot-well whenever I sat in the driver's seat (160 lbs. + 20 lbs.). Each individual case (e.g. Left 150) is conducted for 30 independent wheel alignment measurements including caster sweeps with the exception of the Left 600 case. The Left 600 case is conducted for only 11 individual measurements due to equipment failure. This equipment failure will be discussed in further detail within Chapter 5. This leads to a total of 491 individual wheel alignment measurements taken for this experiment. In regards to load positioning, Figure 27 displays where load is applied for each load case.

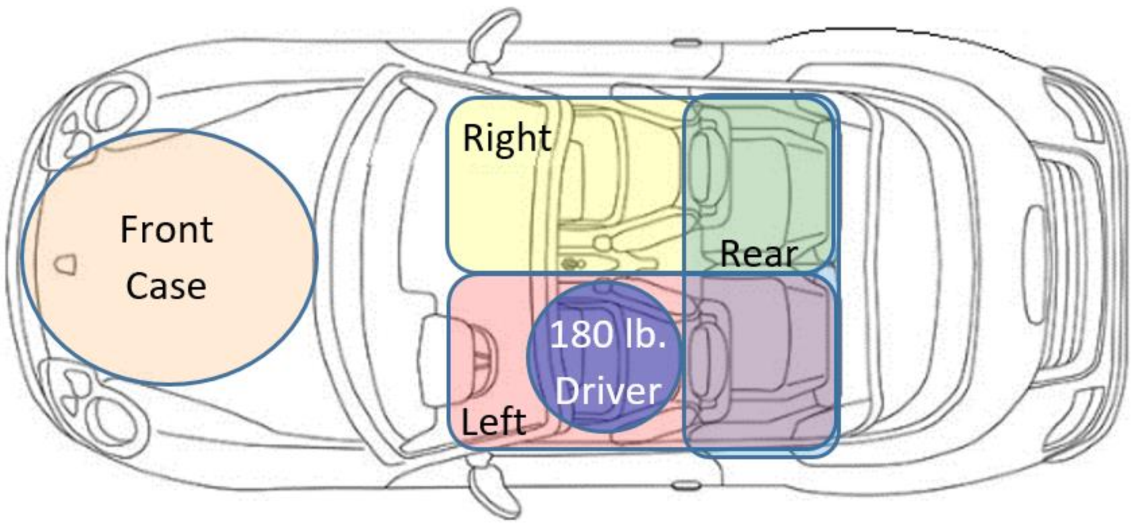


Figure 27: Load Positioning Areas

Since the right load and left load cases cover a large area of space, a certain method is used to better distribute load as it increases per every set. First, the front seats are moved completely forward to increase room in the rear. Table 3 shows the weight distribution

Table 3: Sandbag Distribution – Left and Right Load

		Sandbag Distribution			
	Sandbag #	**150 lb.**	**300 lb.**	**450 lb.**	**600 lb.**
Left Case	Front Trunk	0	0	0	1
	Front Seat	1	2	3	4
	Rear Foot-well	1	2	3	3
	Rear Seat	1	2	3	4
Right Case	Front Trunk	0	0	0	1
	Front Seat	2	3	6	7
	Rear Foot-well	1	2	2	2
	Rear Seat	0	1	1	2

for each case. This table assumes that load is placed on the same side as the indicated case. The reason for the difference in distribution from left and right is because there is a driver in the driver's seat. In regards to the front and rear cases, weight can be applied evenly with ease since the driver is not in the way.

3.2 Wheel Alignment Procedure

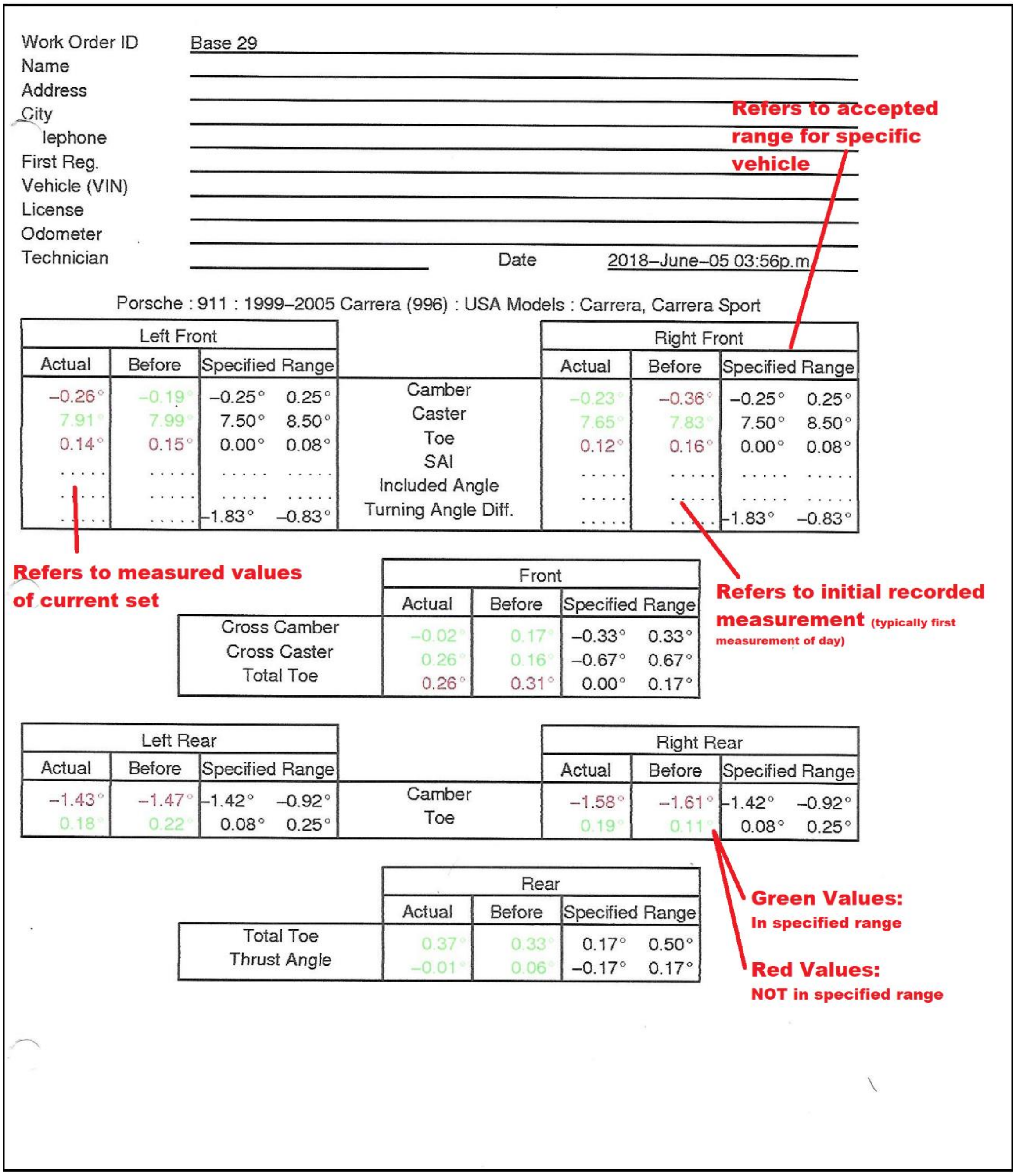
To collect all wheel alignment measurements including caster values, a caster sweep needs to be performed. A caster sweep is a type of procedure which consists of turning the front wheels back and forth and then locking straight ahead. This procedure is done through the Hunter PA130 with one person operating the console and one person turning the vehicle's steering wheel. The PA130 is placed in a position where the steering wheel person can clearly see the monitor. After the console operator starts the caster sweep, two digital needles are shown on the display screen. Each needle represents the angular position of one wheel (left for LF and right for RF). As the steering wheel is turned, the needles float over a color bar. The person holding the steering wheel will then turn it so that the needles float over green. The first task for the steering wheel person is to turn the wheel roughly 180 degrees to the right from the center position until both needles hover over green and are accepted by the console. The second task is for the person to turn the steering wheel 180 degrees to the left from the center position until both needles hover over green again. Once the console accepts those movements, the steering wheel user centers the steering wheel. A needle on the display screen will verify that the wheels are in fact straight ahead. The console operator can then manually finish the caster sweep.

An interesting note should be mentioned when conducting caster sweeps. When a person turns the steering wheel either to the left or to the right during a caster sweep, the inner wheel will always be accepted at a lesser steering wheel turning angle than the outer wheel. The reason for this is due to Ackerman steering. Ackerman steering is a geometry design which helps to prevent tire slipping in turns. Rather than having both wheels turn at the same angle, the inner wheel turns at a greater angle than the outer wheel. This allows both wheels to have a turning radius about the same center point. If this were not done, each wheel would have a radius about a different center point which would lead to tire slip.

Once a caster sweep has been performed, the diagnostic screen on the PA130 will update with a new caster value (as well as displaying all other suspension geometry

Figure 28: Caster Sweep Driver’s View

measurements). A printout is taken with all of these measurements and then it is recorded manually into a separate file. Figure 29 shows that initial printout.



Work Order ID Base 29
Name
Address
City
lephone
First Reg.
Vehicle (VIN)
License
Odometer
Technician
Date 2018–June–05 03:56p.m.

Porsche : 911 : 1999–2005 Carrera (996) : USA Models : Carrera, Carrera Sport

Left Front					Right Front			
Actual	Before	Specified Range			Actual	Before	Specified Range	
–0.26°	–0.19°	–0.25°	0.25°	Camber	–0.23°	–0.36°	–0.25°	0.25°
7.91°	7.99°	7.50°	8.50°	Caster	7.65°	7.83°	7.50°	8.50°
0.14°	0.15°	0.00°	0.08°	Toe	0.12°	0.16°	0.00°	0.08°
.....	.....	.....	.....	SAI	.....	.....	.....	.....
.....	.....	.....	.....	Included Angle	.....	.....	.....	.....
.....	.....	–1.83°	–0.83°	Turning Angle Diff.	.....	.....	–1.83°	–0.83°

	Front			
	Actual	Before	Specified Range	
Cross Camber	–0.02°	0.17°	–0.33°	0.33°
Cross Caster	0.26°	0.16°	–0.67°	0.67°
Total Toe	0.26°	0.31°	0.00°	0.17°

Left Rear					Right Rear			
Actual	Before	Specified Range			Actual	Before	Specified Range	
–1.43°	–1.47°	–1.42°	–0.92°	Camber	–1.58°	–1.61°	–1.42°	–0.92°
0.18°	0.22°	0.08°	0.25°	Toe	0.19°	0.11°	0.08°	0.25°

	Rear			
	Actual	Before	Specified Range	
Total Toe	0.37°	0.33°	0.17°	0.50°
Thrust Angle	–0.01°	0.06°	–0.17°	0.17°

Figure 29: Wheel Alignment Printout

On each printout, there are six groups of information. These groups are ‘Left Front’, ‘Right Front’, Left Rear’, Right Rear’, ‘Front’, and ‘Rear’. Each group has its own set of data, either for each wheel or for front or rear suspension. In Figure 29’s case, the printout refers to the 29th set of the base load case. Each case has its own printout (so a total of 491 printouts). Once the 30th set has been completed for a given case, the alignment stand is removed with the pallet jack and the four-post platform is brought to

Figure 30: Four-Post Position for Sandbag Loading

the floor. We can then safely add or distribute sandbag weight for the next case.

3.3 Data Collection

During experimentation, the data printout results were transferred to Excel sheets for ease of data manipulation. This was also done for each wheel load measurement. To avoid clutter within the paper, the raw input data will be added in the Appendix. To give the reader a better idea of how data will be manipulated in the next section, Table 4 shows the general layout of the raw input data used. Each row represents 30 rows (for 30 measurements) with the exception of the Left 600 case. The data in Table 4 represents the first measurement done for each case.

Table 4: Raw Data General Layout

	LF				RF				LR			RR		
Load Pos.	Camber	Caster	Toe	Load Val	Camber	Caster	Toe	Load Val	Camber	Toe	Load Val	Camber	Toe	Load Val
Base	-0.19	7.99	0.17	712	-0.37	7.83	0.14	630	-1.47	0.21	1184	-1.6	0.11	1076
Left 150	-0.26	7.76	0.03	765	-0.57	7.5	0.01	680	-1.5	0.28	1242	-1.82	0.18	1125
Left 300	-0.27	7.98	-0.04	821	-0.75	7.75	-0.05	715	-1.7	0.37	1311	-2.1	0.23	1158
Left 450	-0.11	8.21	-0.02	821	-0.83	7.77	-0.02	667	-2.02	0.23	1408	-2.39	0.29	1198
Left 600	-0.06	8.18	-0.1	716	-1.09	7.73	-0.08	728	-1.89	0.41	1173	-2.71	0.21	1151
Right 150	-0.43	7.89	0.05	716	-0.31	7.61	0.04	728	-1.84	0.07	1173	-1.6	0.14	1151
Right 300	-0.64	7.85	-0.02	733	-0.34	7.83	-0.02	776	-1.99	0.32	1217	-1.77	0.23	1227
Right 450	-0.77	7.93	-0.08	740	-0.32	7.73	-0.08	810	-2.18	0.26	1238	-1.93	0.25	1311
Right 600	-0.99	7.95	-0.19	767	-0.29	7.89	-0.17	882	-2.33	0.34	1260	-1.97	0.3	1358
Front 150	-0.46	7.47	-0.03	795	-0.66	7.28	-0.05	747	-1.39	0.22	1163	-1.54	0.16	1078
Front 300	-0.71	7.29	-0.21	910	-0.87	7.1	-0.24	840	-1.33	0.22	1131	-1.43	0.17	1061
Front 400	-0.73	7.26	-0.34	979	-1	6.95	-0.34	892	-1.32	0.22	1135	-1.37	0.13	1049
Front 500	-0.92	7.02	-0.49	1028	-1.14	6.9	-0.4	978	-1.25	0.2	1116	-1.36	0.16	1044
Back 150	-0.35	7.93	0.06	728	-0.4	7.75	0.07	697	-1.71	0.29	1231	-1.77	0.24	1175
Back 300	-0.47	8.09	0.02	750	-0.54	7.82	0.03	726	-1.86	0.42	1369	-2.18	0.24	1317
Back 450	-0.45	8.2	0.01	758	-0.49	8.13	0	726	-2.2	0.34	1369	-2.32	0.28	1317
Back 600	-0.45	8.33	-0.03	763	-0.53	8.01	-0.03	736	-2.46	0.4	1453	-2.61	0.34	1381

CHAPTER 4: RESULTS

4.1 Separation and Organization

After all data is collected and inputted into the initial Excel sheet, data is separated by wheel, then by measurement type, and then by load position and load magnitude. An example of this would be to look at LF camber for the rear 150 lbs. load case. This consists of 30 camber measurements. Individual wheel load measurements are set to the side for this portion of organization. To continue with the "LF Camber, Rear 150" example, the data is plotted as a line graph to view variations in camber value across multiple iterations. Figure 31 shows that variation.

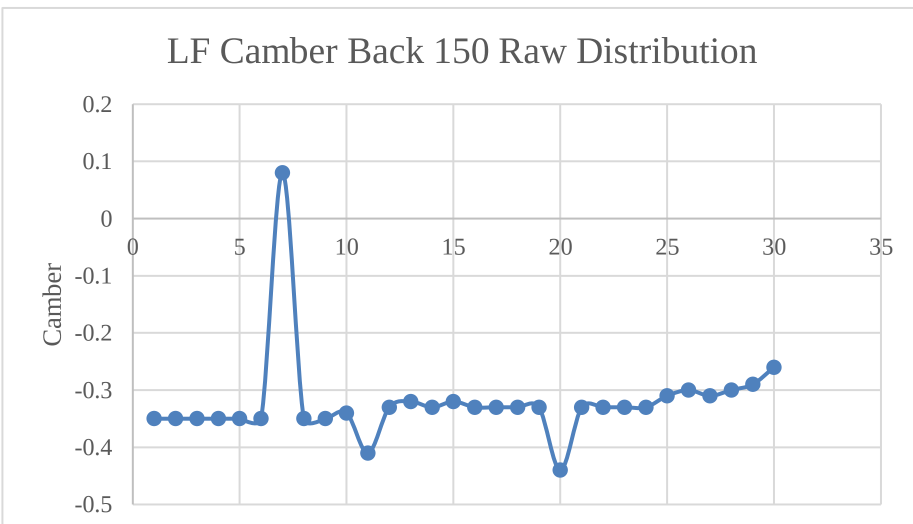


Figure 31: LF Camber Rear 150 Raw Distribution

As with all forms of raw data, anomalies are bound to appear. In order to combat this, a statistical approach is used to identify anomalies. There are two benefits of doing this, rather than manually singling out values. One benefit is that it prevents bias. As a researcher, I expect a certain outcome. Because of that, I may unconsciously single out a few values to better support a hypothesis. As with Figure 31, I tried to choose an example with obvious outliers to give the reader a better idea of my thought process. It's important to note that many of the cases do not have outliers that are as obvious as Figure 31's. The second benefit of using a statistical approach is that it is very time efficient. Now that data is separated into multiple categories (10 to be specific), I am now working with 4,910 individual points. Using a set of formulas to look over these helps to drastically cut down on time.

A couple terms need to be defined before sharing the method used to find outliers. Quartiles are used to calculate the outliers. A quartile is a value within a list which helps to divide that list into four groups. This leads to a total of three quartiles per list of values. The second term is an interquartile range (IQR). If one were to picture a set of data in numerical order, the second quartile would be the median. The first and third quartiles would be the middle values of the upper and lower section respectively. The interquartile range is equivalent to the first quartile subtracted from the third quartile.

The statistical definition of an outlier is any point which is above the third quartile by 1.5 times the IQR or below the first quartile by 1.5 times IQR. This 1.5 value is the most commonly used value in regards to finding outliers, although other values can be acceptable for use also. Since this is the most commonly used value, I used it for this experiment too. Below shows the formulas for the maximum and minimum bounds.

$$Accepted\ Max\ Upperbound = Q_3 + (1.5 * IQR)$$

$$Accepted\ Min\ Lowerbound = Q_1 - (1.5 * IQR)$$

These are first solved in Excel for each individual case. Once this is done, the following Excel formula is used to identify outliers. For this, assume that the first data value lies within cell A1 and that the accepted max upperbound and accepted min lowerbound lie within cells B1 and B2 respectively.

$$OR(A1 > \$B\$1, A1 < \$B\$2)$$

This will give a true or false answer ("false" meaning not an outlier and "true" meaning outlier). This formula can then be dragged for every single value within a data set to identify outliers. The $ signs keep the upperbound and lowerbound values a constant target no matter which measurement value is being analyzed. Now that outliers are identified, a new plot is made to show the new variation.

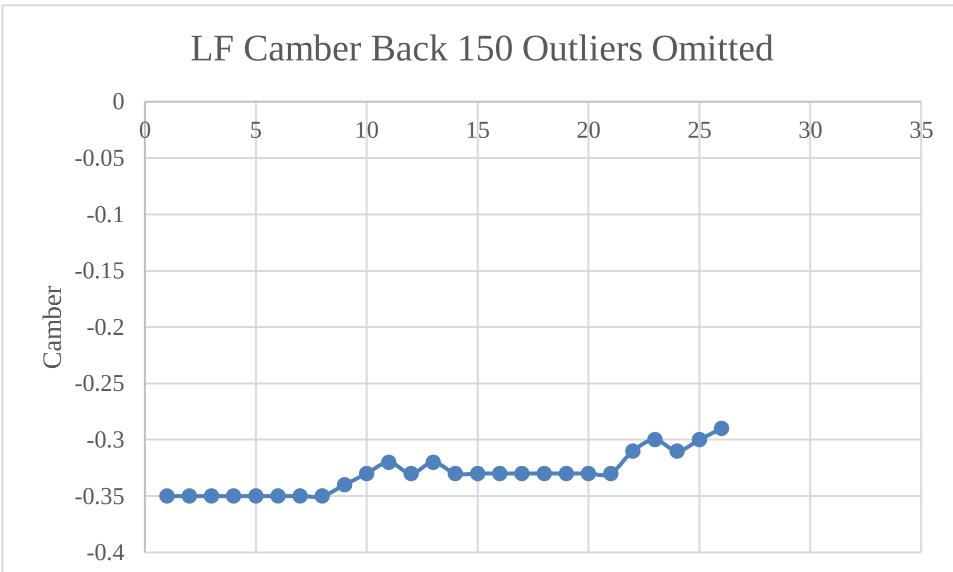


Figure 32: LF Camber Rear 150 Outliers Omitted

This is then done for every single case. Each case plot is then analyzed to ensure that the formula cut out major outliers. While doing this, a certain pattern was noticed with the Right 150 case. Within most Right 150 plots (whether it be camber or toe), a pronounced shift in data was observed. Both camber and toe would remain relatively constant, then shift up drastically and continue a relatively constant distribution. This means that there must have been a mistake midway through the Right 150 case experiment set. This prevented the outlier formula from affecting this case properly. To fix this, I manually omitted all Right 150 data before the shift regardless if a shift was present or not (no effect in caster and RR wheel). The omission was taken from the 1st to the 13th iteration also. Some shifts happened slightly before this and some slightly after this. The 13th value was chosen as an average shift point among the Right 150 measurements. Figures 33 and 34 show an example of the before and after for this.

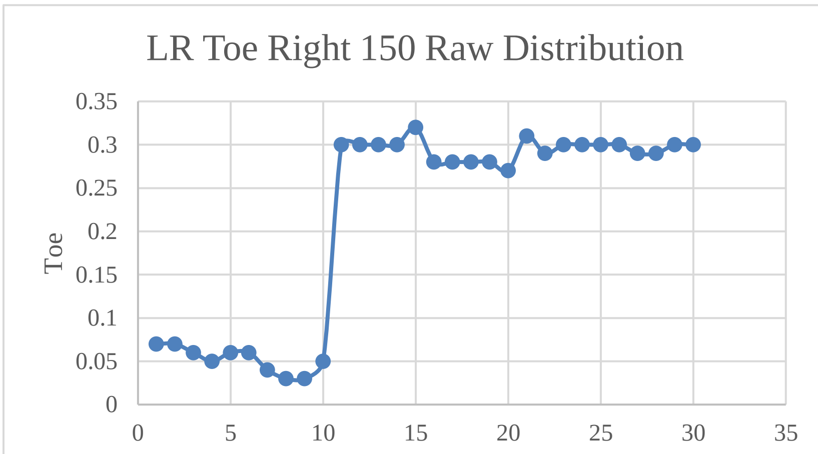


Figure 33: LR Toe Right 150 Shift

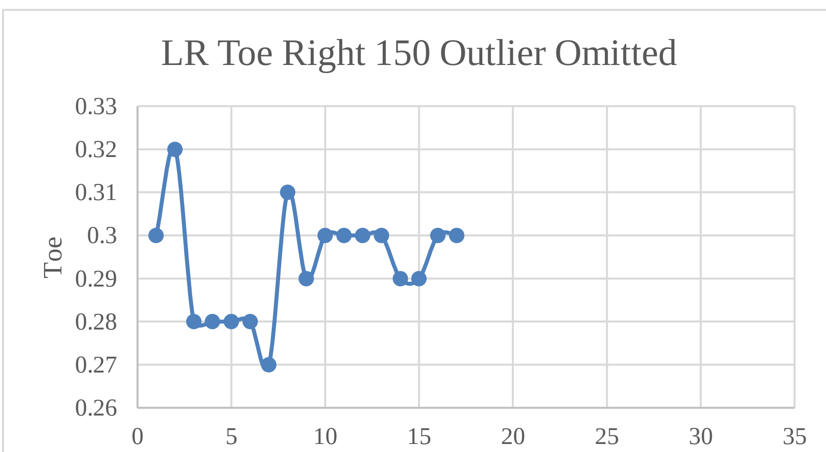


Figure 34: LR Toe Right 150 Shift Omitted

Values were taken after the 13th point rather than before the 13th point because they represented more realistic values for camber and toe when compared to similar cases, such as Right 300 and Base cases. After all cases are calculated for outliers, plotted, and analyzed, standard deviation is calculated for each set of data. Standard deviation is the chosen method for observing variability because it uses the same units as the targeted measurement. This makes it easier to process information when both variability and measurement values are compared in the same figure (which will be done in subsequent pages). The data can now be organized into a general format for plotting. One purpose of this format allows for the comparison of measurement value vs wheel load with each measurement value displaying a confidence level. Since standard deviation represents the confidence level, each measurement value displayed is the average of 30 measurements. The second purpose of this format is to plot standard deviation versus wheel load magnitude. Tables 5 through 7 share the formatted data tables. The red values represent calculated outliers for the standard deviation versus wheel load magnitude plots. These are standard deviation outliers rather than individual measurement outliers. They are calculated in the same manner as the individual measurement outlier calculations.

Table 5: Final Camber Organization

	Camber											
	LF			RF			LR			RR		
	Whl Ld	Average	St. Dev.	Whl Ld	Average	St. Dev.	Whl Ld	Average	St. Dev.	Whl Ld	Average	St. Dev.
Base	700.6667	-0.19555	0.019309	644.6667	-0.34222	0.016851	1173.333	-1.47482	0.047635	1093	-1.55482	0.030591
Left 150	763	-0.25795	0.026843	684.667	-0.695	0.02077	1244	-1.5468	0.022212	1122.667	-1.80391	0.021617
Left 300	813.333	-0.31741	0.080854	716.333	-1.099	0.075044	1317.333	-1.80766	0.090469	1159	-2.03233	0.099388
Left 450	818.333	-0.1372	0.00449	672	-0.55652	0.009056	1407.667	-2.14143	0.05749	1208	-2.3925	0.009
Left 600	883	-0.06	0.007746	697.5	-0.82464	0.008307	1473	-1.884	0.012	1407.667	-2.717	0.01479
Right 150	717.3333	-0.35235	0.012616	717	-0.29705	0.011765	1186.333	-1.69412	0.016109	1155	-1.64882	0.011315
Right 300	736	-0.63111	0.008749	774.6667	-0.342	0.038764	1209	-1.95448	0.018862	1221.333	-1.77	0.017321
Right 450	739	-0.75923	0.009577	806	-0.32538	0.016923	1237.667	-2.084	0.060033	1324	-1.91366	0.055527
Right 600	769	-1.003	0.011299	881.333	-0.285	0.007792	1261	-2.393	0.029229	1355.667	-1.96066	0.024074
Front 150	797.6667	-0.46888	0.012571	745	-0.64652	0.006984	1162	-1.39885	0.013958	1078	-1.5137	0.025261
Front 300	910.3333	-0.70125	0.006654	840.3333	-0.8888	0.017916	1139	-1.30566	0.030625	1057.333	-1.41538	0.014205
Front 400	966.3333	-0.731	0.017861	904.6667	-0.988	0.023152	1129.333	-1.326	0.025768	1053.667	-1.3785	0.032905
Front 500	1028.333	-0.92893	0.014721	987.333	-1.10633	0.042855	1101.667	-1.29033	0.072087	1044	-1.373	0.025968
Rear 150	726.333	-0.33038	0.017205	697.333	-0.39846	0.014058	1228.333	-1.739	0.028275	1169.667	-1.76571	0.025971
Rear 300	748.6667	-0.3908	0.018093	717.3333	-0.48107	0.01012	1296.333	-1.7176	0.144307	1234.333	-2.07607	0.017594
Rear 450	759.6667	-0.4337	0.010237	729	-0.51385	0.017114	1367.333	-2.23793	0.019543	1313	-2.36068	0.017603
Rear 600	769.3333	-0.395	0.078606	732.6667	-0.54727	0.018385	1449.333	-2.4768	0.03426	1377.667	-2.6212	0.032902

Table 6: Final Toe Organization

	Toe											
	LF			RF			LR			RR		
	Whl Ld	**Average**	**St. Dev.**	**Whl Ld**	**Average**	**St. Dev.**	**Whl Ld**	**Average**	**St. Dev.**	**Whl Ld**	**Average**	**St. Dev.**
Base	700.6667	0.14448	0.016414	644.6667	0.131724	0.013608	1173.333	0.214482	0.020655	1093	0.174814	0.019123
Left 150	763	0.013666	0.009264	684.667	-0.04536	0.006478	1244	0.258333	0.027955	1122.667	0.154666	0.024885
Left 300	813.333	-0.04269	0.008859	716.333	-0.08455	0.008653	1317.333	0.344482	0.008544	1159	0.23266	0.007272
Left 450	818.333	-0.02392	0.007718	672	0.01367	0.007857	1407.667	0.622083	0.044251	1208	0.220909	0.009
Left 600	883	-0.09272	0.011355	697.5	-0.0222	0.00782	1473	0.411	0.007	1407.667	0.223	0.005961
Right 150	717.3333	0.09705	0.008235	717	0.95882	0.007715	1186.333	0.293529	0.012339	1155	0.171176	0.014505
Right 300	736	-0.02467	0.015434	774.6667	-0.01733	0.013646	1209	0.279655	0.022664	1221.333	0.22933	0.018245
Right 450	739	-0.07464	0.009056	806	-0.07481	0.007389	1237.667	0.25633	0.027626	1324	0.26333	0.02241
Right 600	769	-0.17724	0.01387	881.333	-0.1731	0.012064	1261	0.315185	0.009952	1355.667	0.30931	0.015521
Front 150	797.6667	-0.04214	0.008175	745	-0.04833	0.013683	1162	0.215172	0.00725	1078	0.140344	0.021251
Front 300	910.3333	-0.22666	0.012202	840.3333	-0.23462	0.0097	1139	0.193	0.021932	1057.333	0.13866	0.028371
Front 400	966.3333	-0.3495	0.009206	904.6667	-0.347	0.00781	1129.333	0.198	0.017493	1053.667	0.131875	0.009499
Front 500	1028.333	-0.44333	0.007454	987.333	-0.4433	0.012848	1101.667	0.206956	0.052373	1044	0.168235	0.011998
Rear 150	726.333	0.06111	0.006285	697.333	0.060714	0.007035	1228.333	0.260689	0.013113	1169.667	0.207857	0.009007
Rear 300	748.6667	0.023103	0.006488	717.3333	0.01586	0.008517	1296.333	0.391724	0.013663	1234.333	0.26633	0.02523
Rear 450	759.6667	-0.00615	0.007378	729	-0.01103	0.008845	1367.333	0.359666	0.020572	1313	0.29	0.006831
Rear 600	769.3333	-0.032	0.009798	732.6667	-0.03786	0.006739	1449.333	0.388571	0.022474	1377.667	0.3433	0.015396

Table 7: Final Caster Organization

Caster						
	LF			RF		
	Whl Ld	Average	St. Dev.	Whl Ld	Average	St. Dev.
Base	700.6667	7.859629	0.041853	644.6667	7.683103	0.062928
Left 150	763	7.820385	0.045918	684.667	7.66882	0.032475
Left 300	813.333	7.947	0.068903	716.333	7.7527	0.035932
Left 450	818.333	8.10833	0.068706	672	7.48846	0.05189
Left 600	883	8.155	0.017464	697.5	7.77518	0.039059
Right 150	717.3333	7.81529	0.051463	717	7.665294	0.052817
Right 300	736	7.84233	0.055419	774.6667	7.739	0.055278
Right 450	739	7.989655	0.04303	806	7.8206	0.078142
Right 600	769	7.89266	0.051051	881.333	7.80333	0.051077
Front 150	797.6667	7.536785	0.049284	745	7.289259	0.048681
Front 300	910.3333	7.33655	0.0483	840.3333	7.056	0.069503
Front 400	966.3333	7.2442	0.035588	904.6667	6.8985	0.045637
Front 500	1028.333	7.07233	0.052958	987.333	6.83266	0.065112
Rear 150	726.333	7.857241	0.040505	697.333	7.6025	0.040499
Rear 300	748.6667	8.074	0.05004	717.3333	7.82	0.040988
Rear 450	759.6667	8.214	0.043711	729	8.060344	0.03306
Rear 600	769.3333	8.3172	0.061222	732.6667	7.9619	0.033052

4.2 Wheel Alignment Results

Two general types of results will be plotted in this section. The first type is an averaged measurement value (camber, caster, or toe) versus individual wheel load. Each value point contains an error bar which represents standard deviation. The purpose of this plot type is to verify that camber, caster, and toe respond as expected when load is increased and then to analyze if any trends are visible in regards to confidence. This observes each wheel for each type of load. Below shares those results.

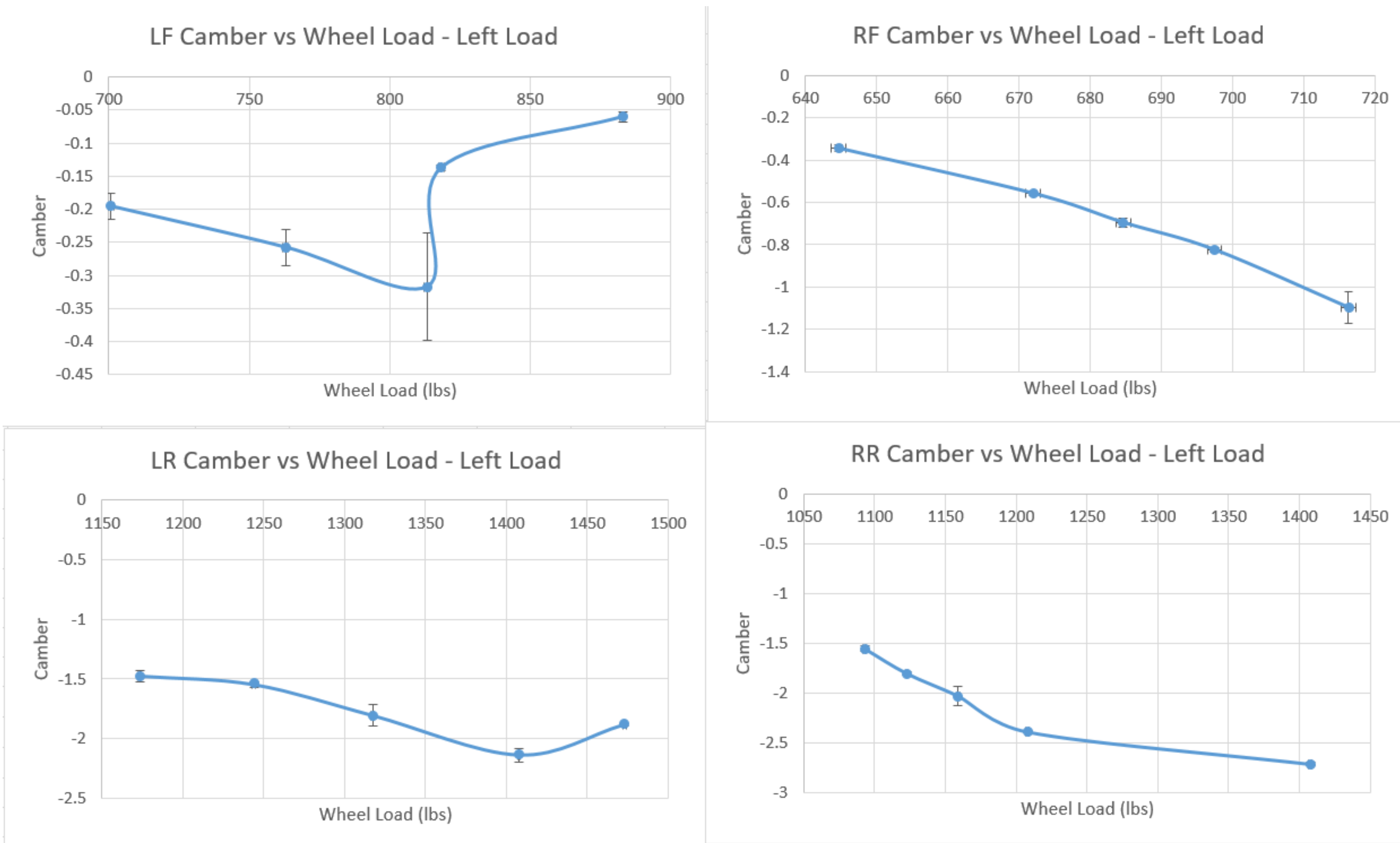


Figure 35: Confidence Plots – Camber Left Load

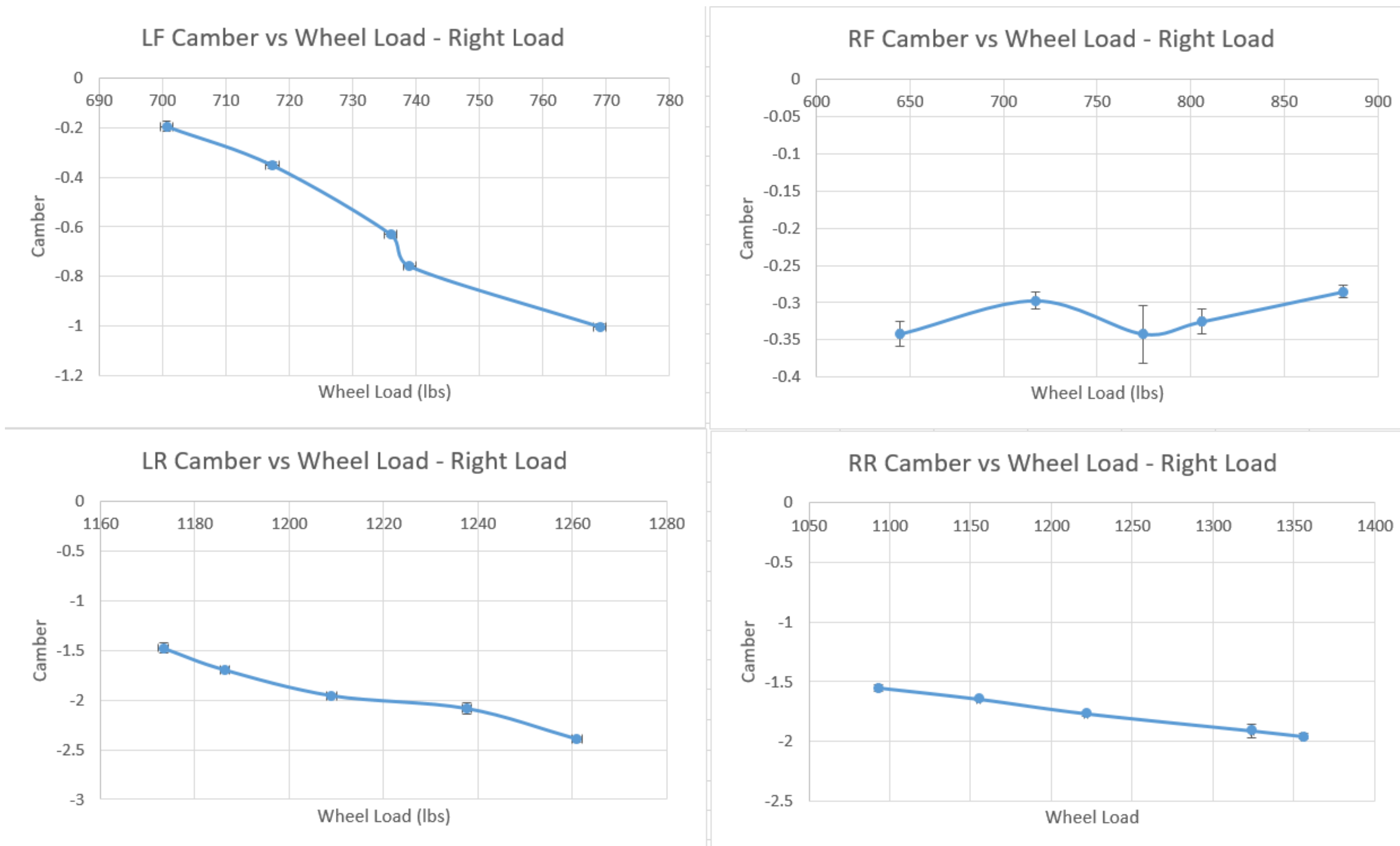


Figure 36: Confidence Plots – Camber Right Load

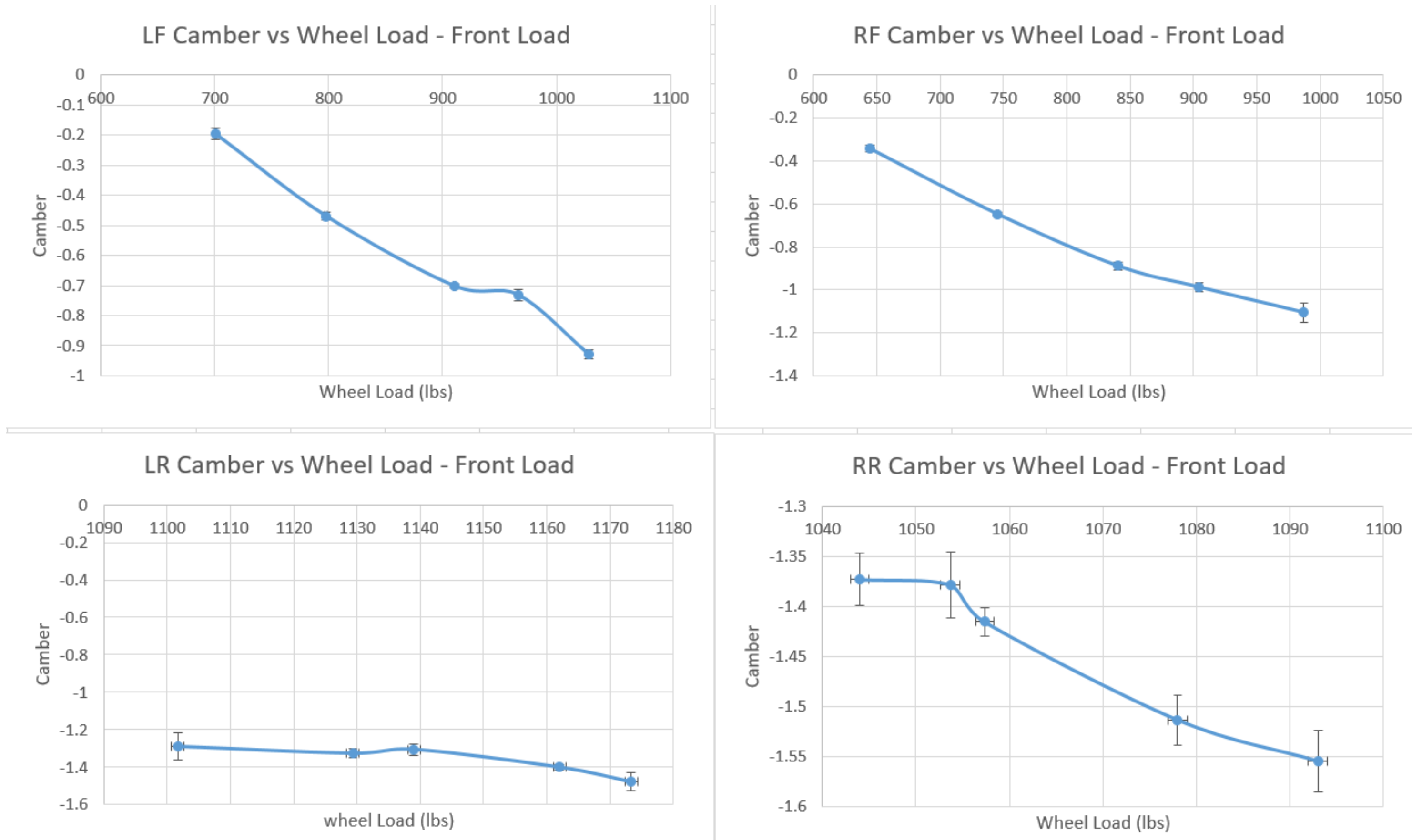


Figure 37: Confidence Plots – Camber Front Load

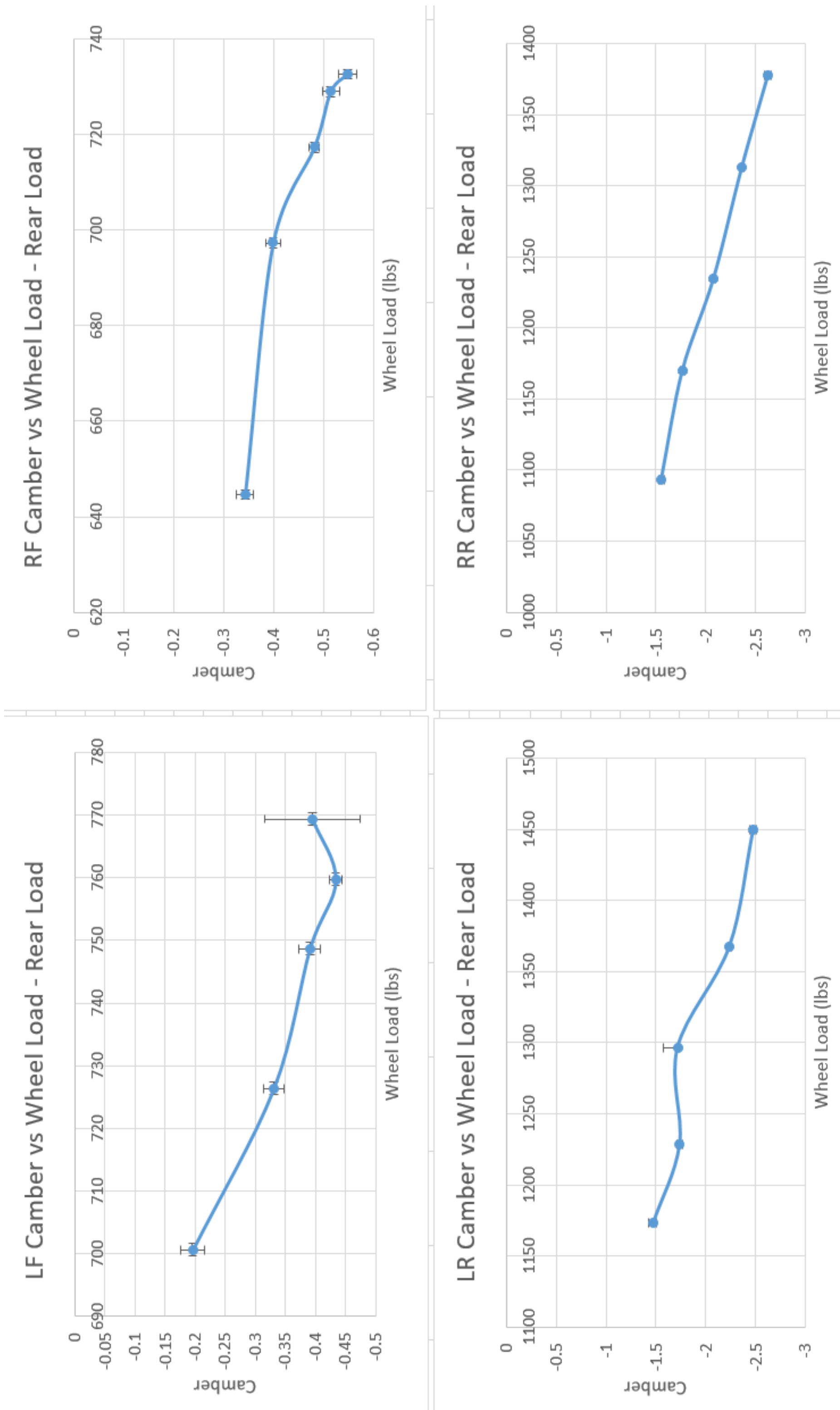


Figure 38: Confidence Plots – Camber Rear Load

Figure 39: Confidence Plots – Toe Left Load

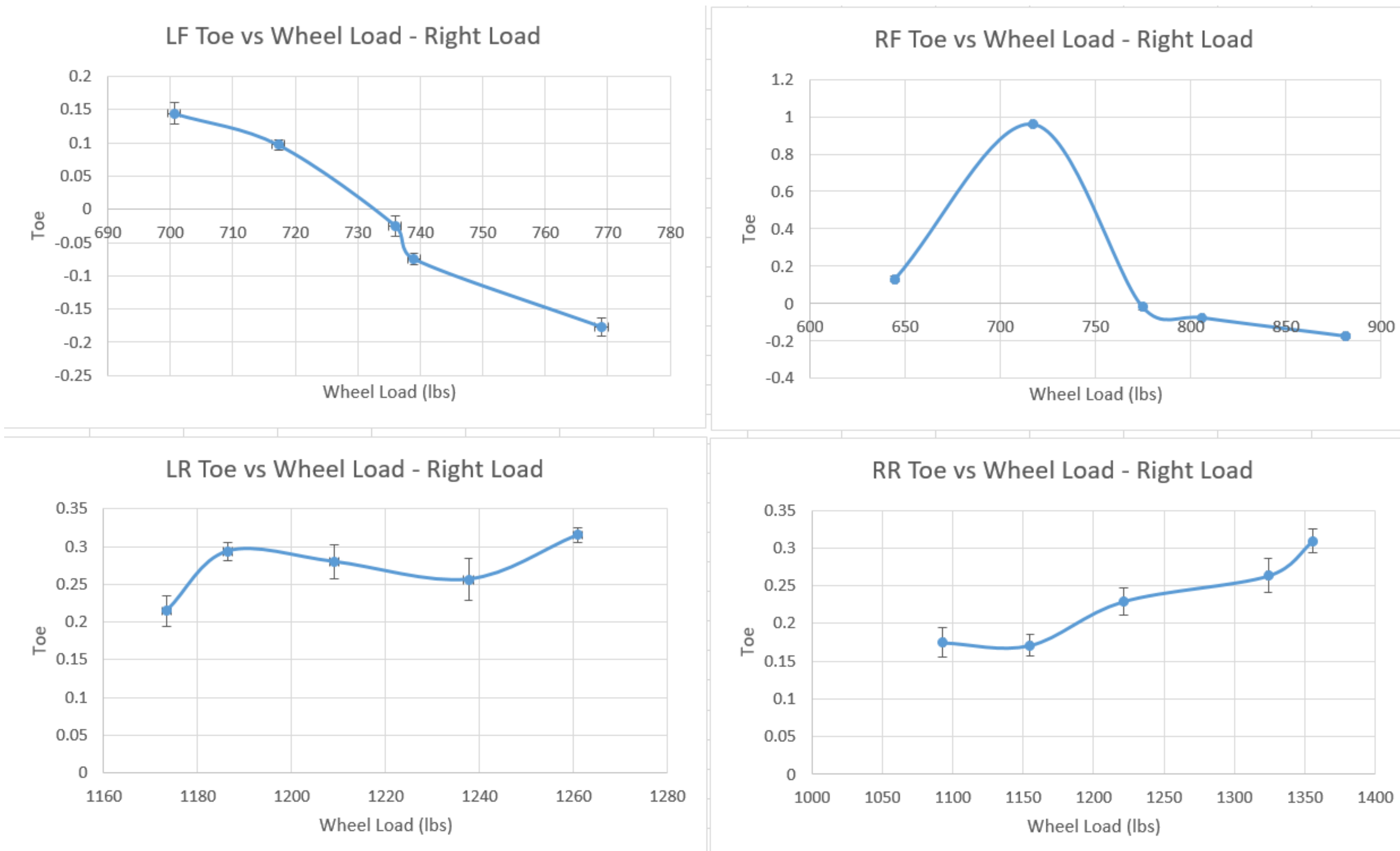


Figure 40: Confidence Plots – Toe Right Load

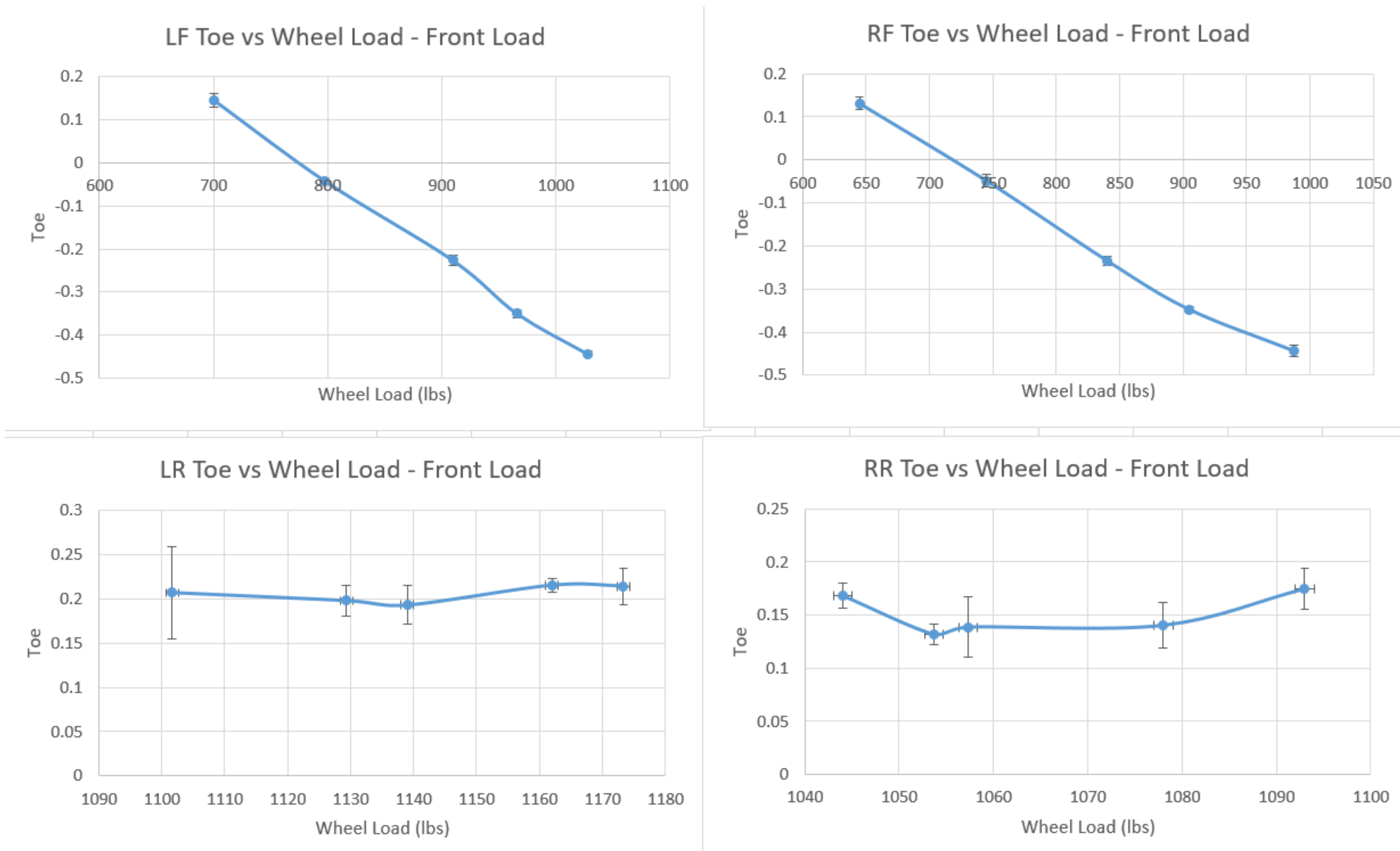


Figure 41: Confidence Plots – Toe Front Load

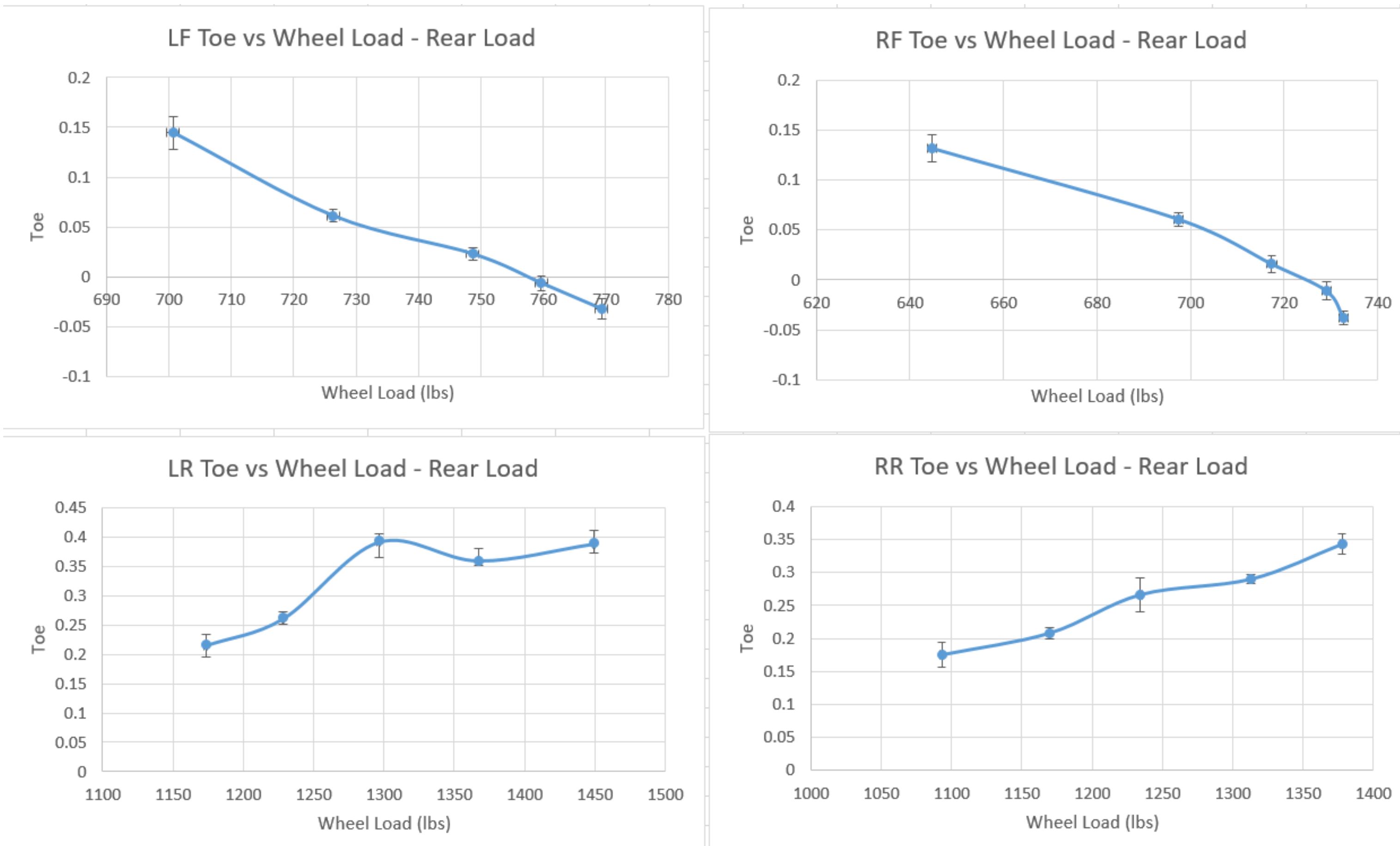


Figure 42: Confidence Plots – Toe Rear Load

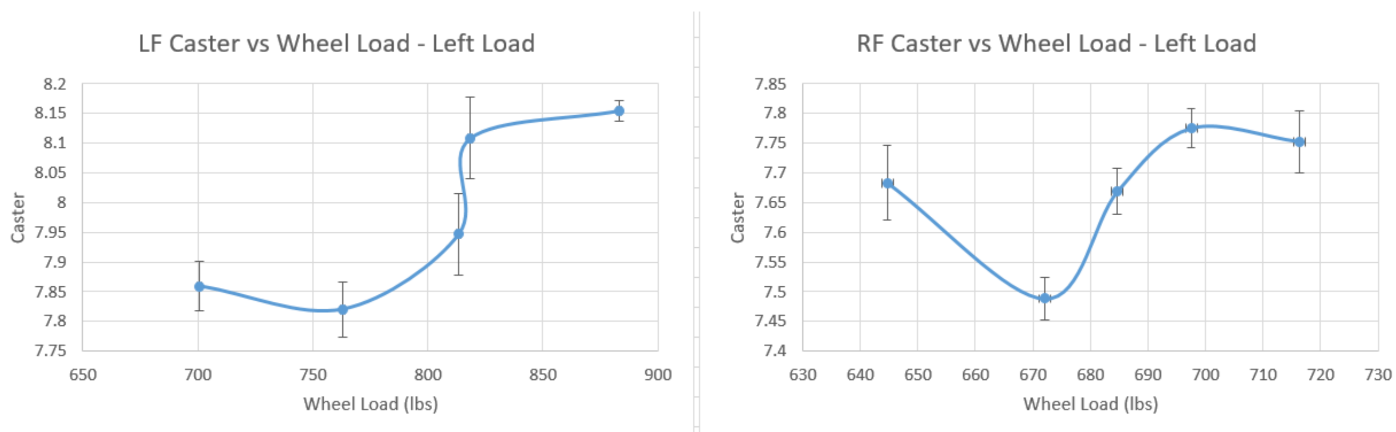
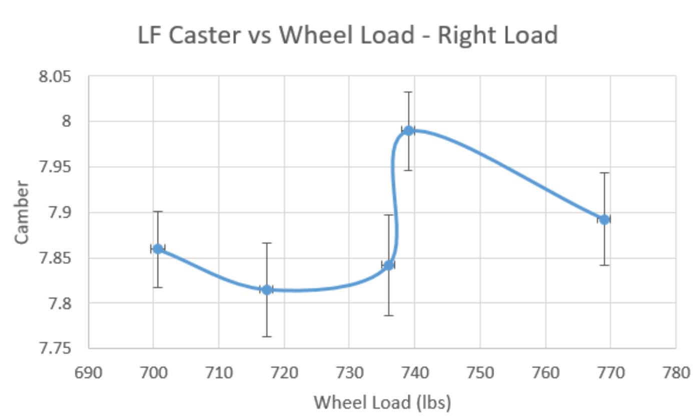


Figure 43: Confidence Plots – Caster Left Load



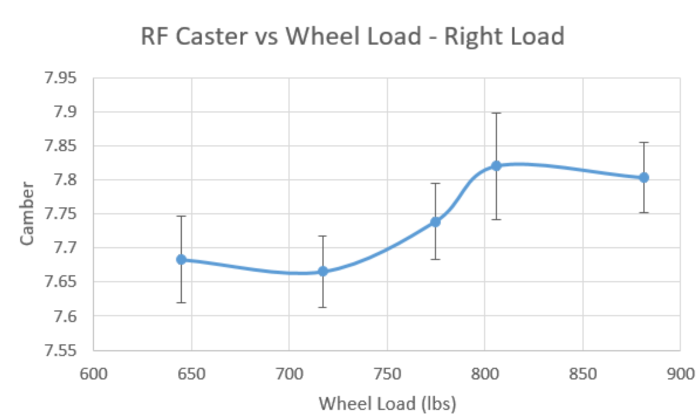


Figure 44: Confidence Plots – Caster Right Load

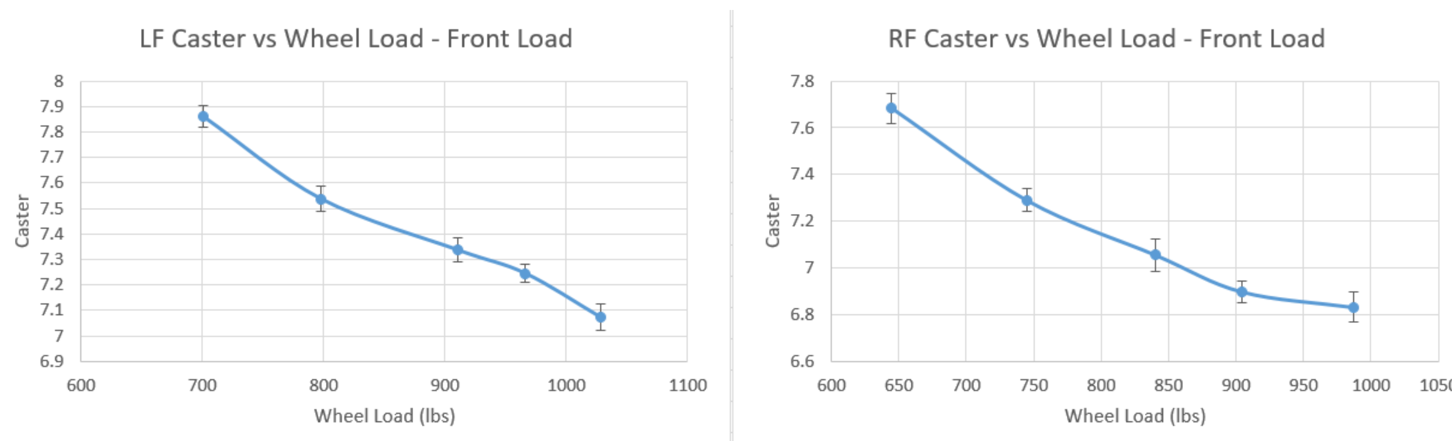


Figure 45: Confidence Plots – Caster Front Load

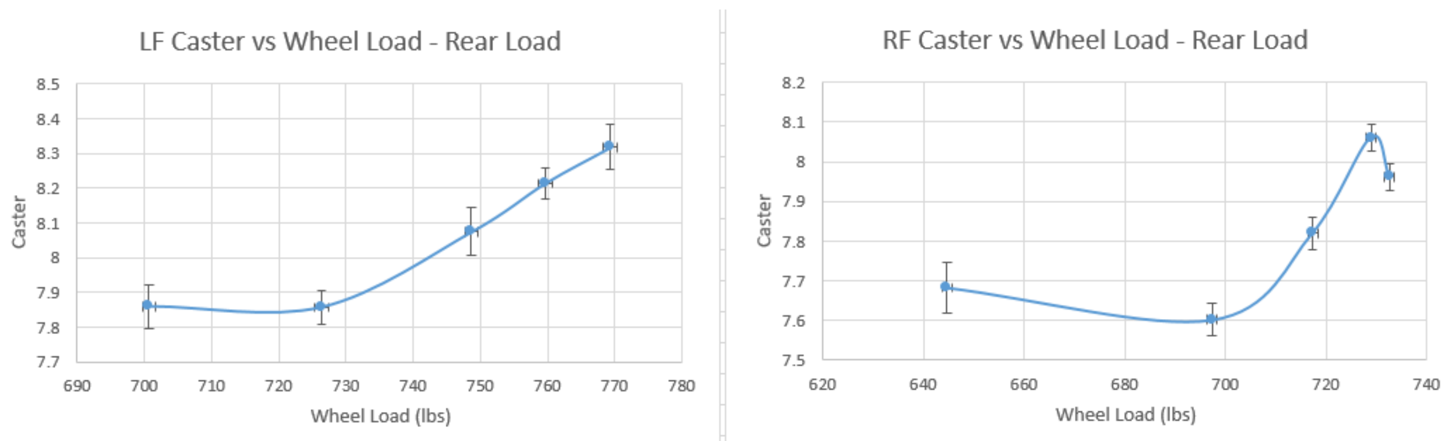


Figure 46: Confidence Plots – Caster Rear Load

Inferences of this will be discussed in Chapter 5. Due to the layout of standard deviation in the above plots, trends are not easily visible. This leads to the secondary type of result. This is to plot standard deviation versus individual wheel load for each wheel and for each load case. Plots will first be tuned to observe how load magnitude affects wheel alignment variability and then plots will be tuned for observing how load positioning affects wheel alignment variability. Trend plots will be shown initially and then supplementary plots will follow for each type of measurement and observation. Summary plots will be included at the end of each observation. The analysis will be discussed in detail in Chapter 5.

Observation 1: Influence of Load Magnitude

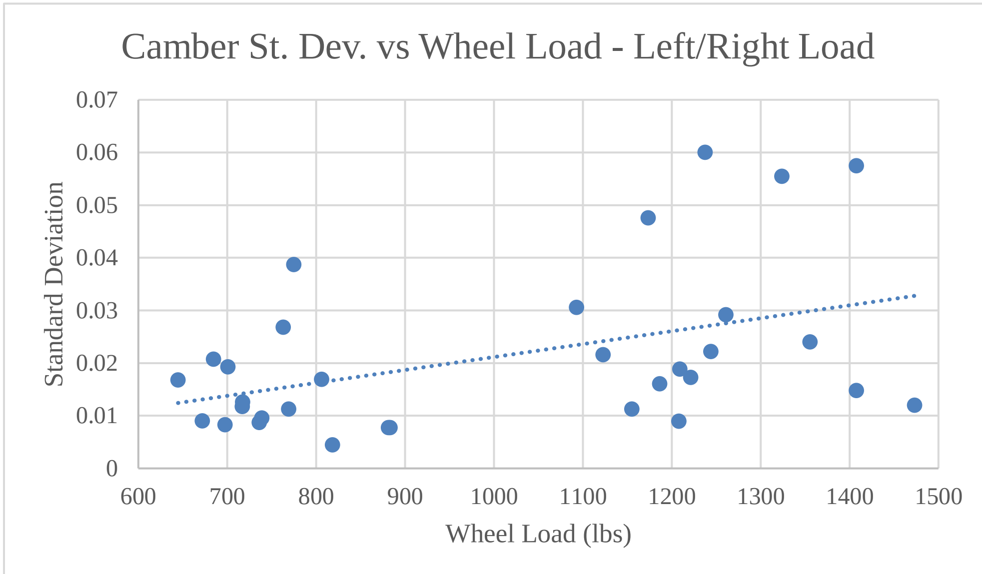


Figure 47: Trend Plot – Camber St. Dev. vs Wheel Load (L&Rt load)

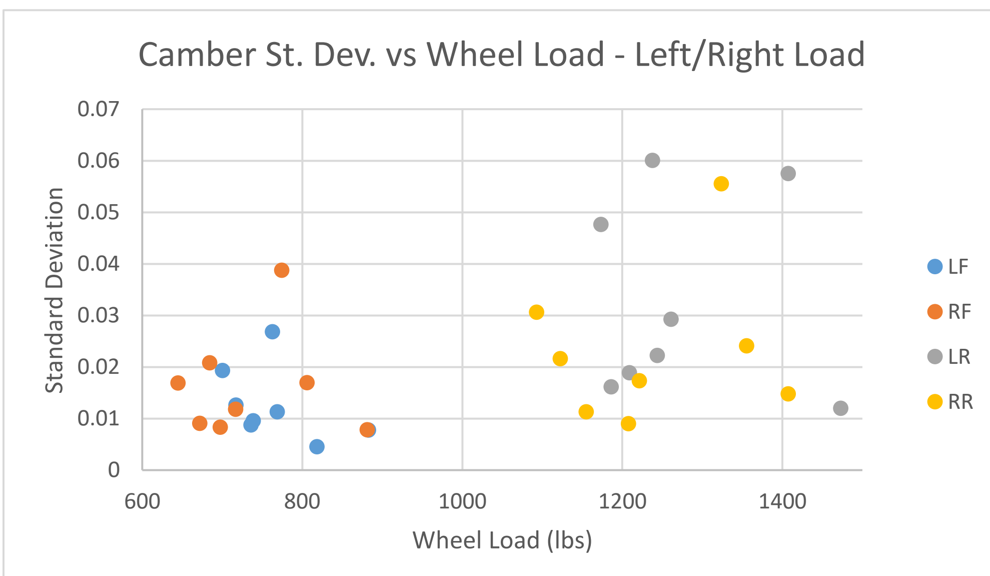


Figure 48: Individual Wheel Plot – Camber St. Dev. vs Wheel Load (L&Rt load)

Figures 47 and 48 have the calculated outliers (from Table 5) omitted. The separated load cases (Figures 49 and 50) show all values. This pattern will repeat for subsequent measurements.

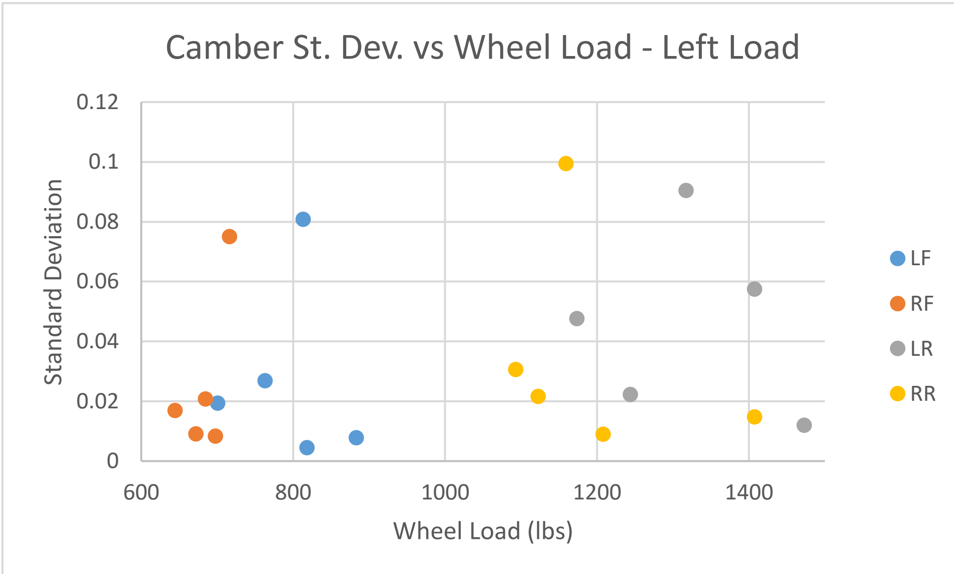


Figure 49: Individual Wheel Plot – Camber St. Dev. vs Wheel Load (L load)

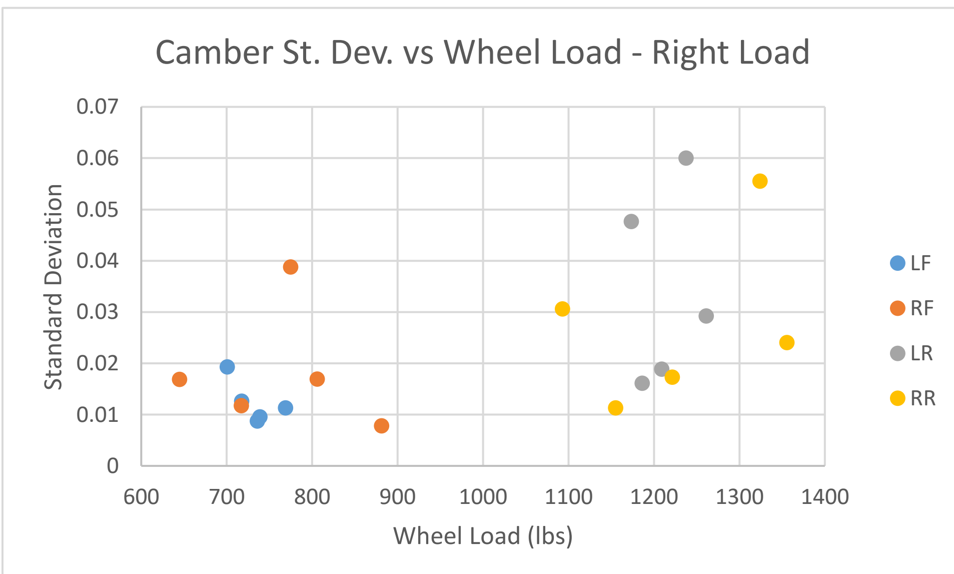


Figure 50: Individual Wheel Plot – Camber St. Dev. vs Wheel Load (Rt load)

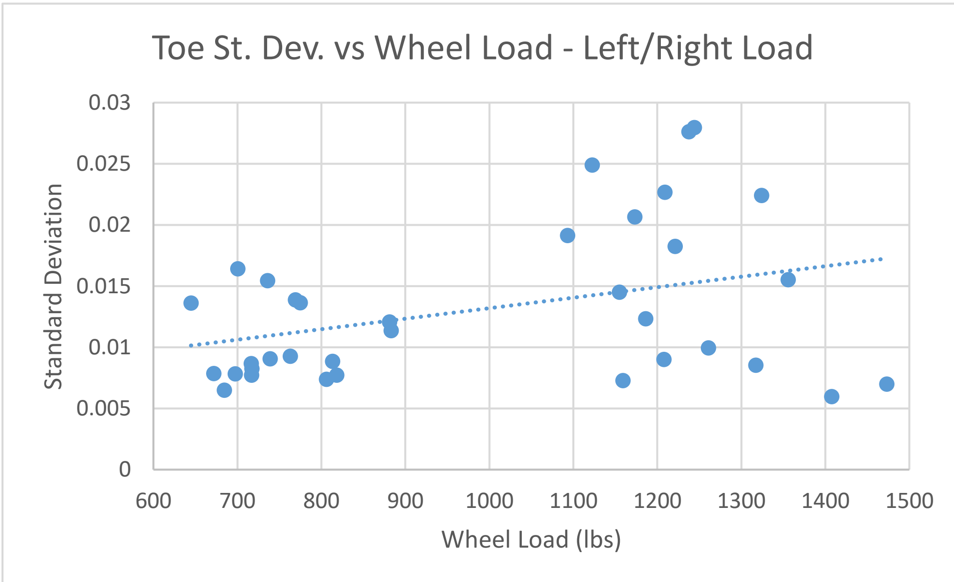


Figure 51: Trend Plot – Toe St. Dev. vs Wheel Load (L&Rt load)

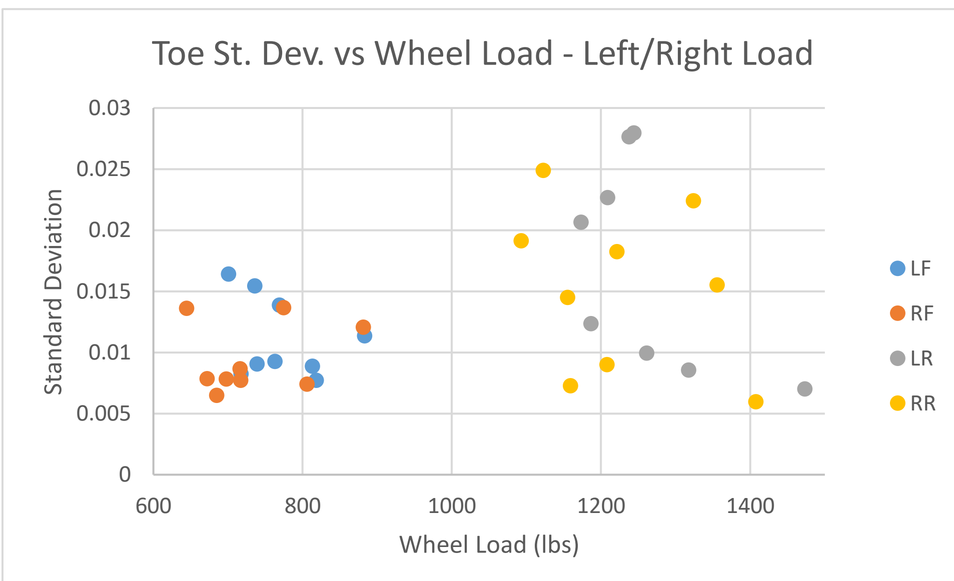


Figure 52: Individual Wheel Plot – Toe St. Dev. vs Wheel Load (L&Rt load)

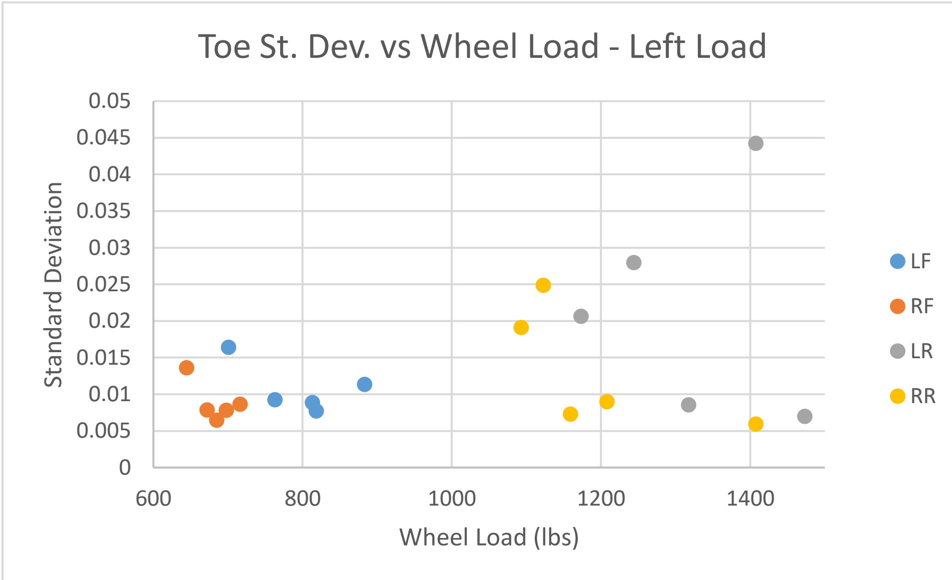


Figure 53: Individual Wheel Plot – Toe St. Dev. vs Wheel Load (L load)

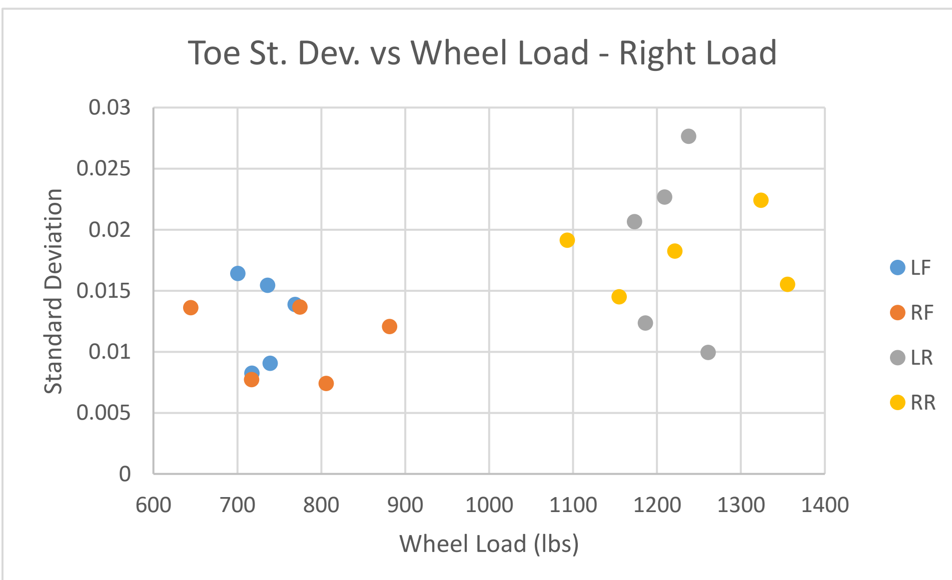


Figure 54: Individual Wheel Plot – Toe St. Dev. vs Wheel Load (Rt load)

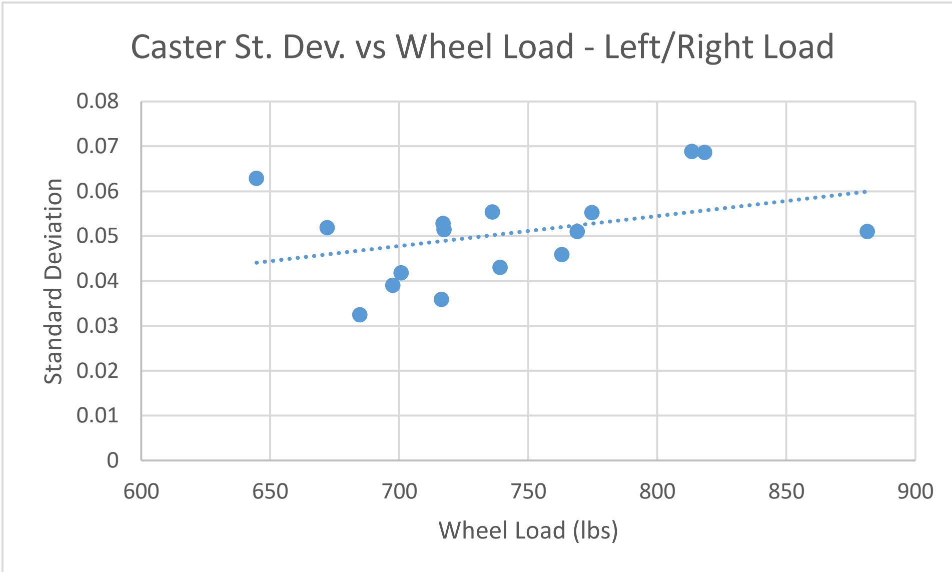


Figure 55: Trend Plot – Caster St. Dev. vs Wheel Load (L&Rt load)

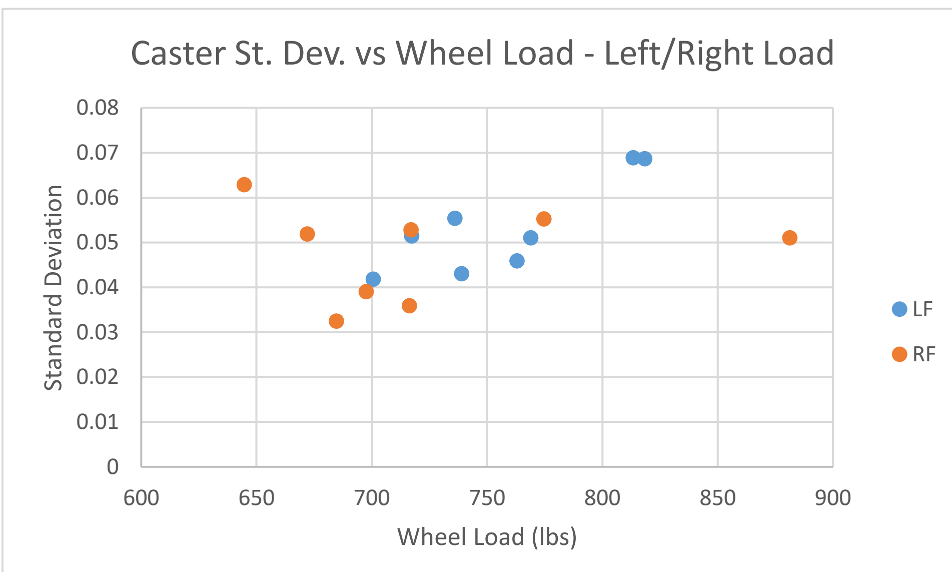


Figure 56: Individual Wheel Plot – Caster St. Dev. vs Wheel Load (L&Rt load)

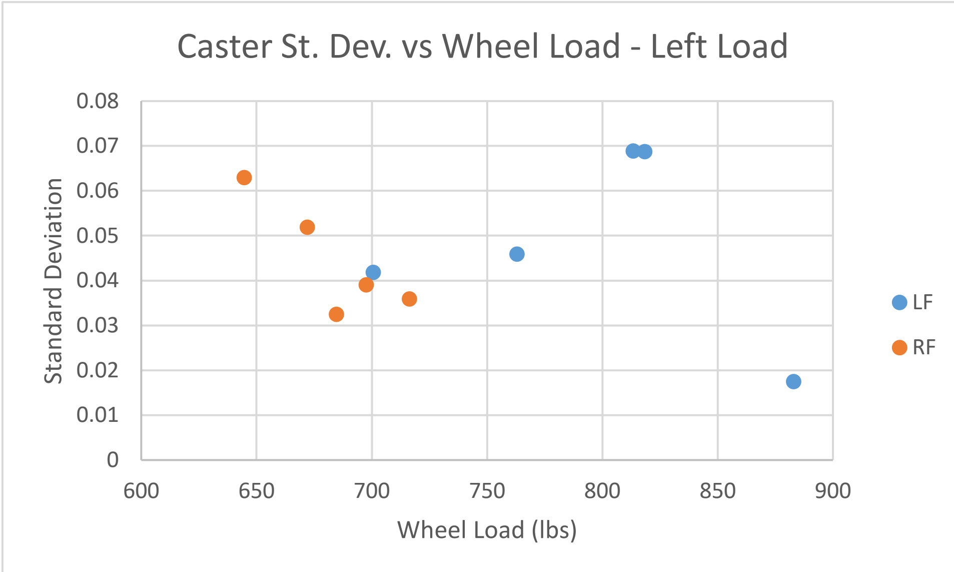


Figure 57: Individual Wheel Plot – Caster St. Dev. vs Wheel Load (L load)

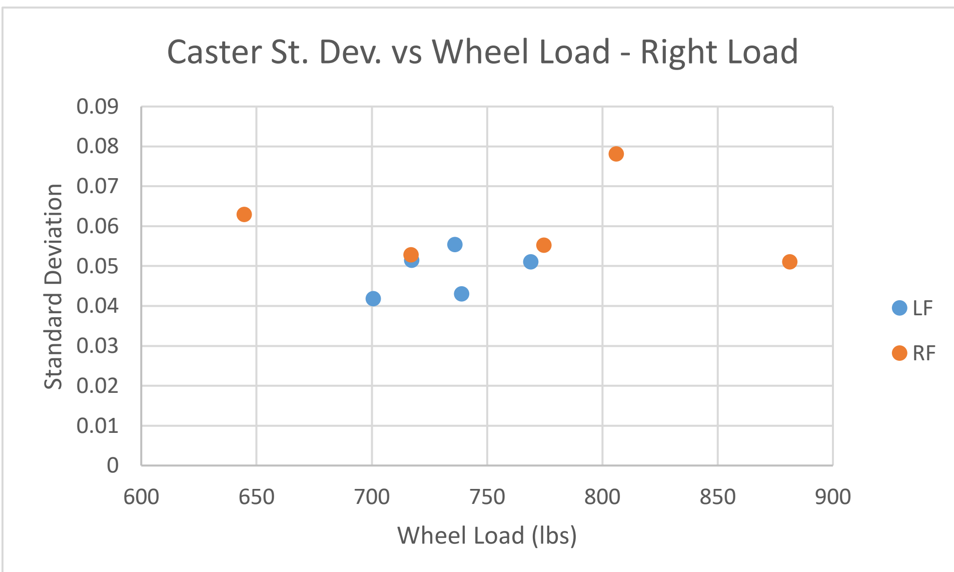


Figure 58: Individual Wheel Plot – Caster St. Dev. vs Wheel Load (Rt load)

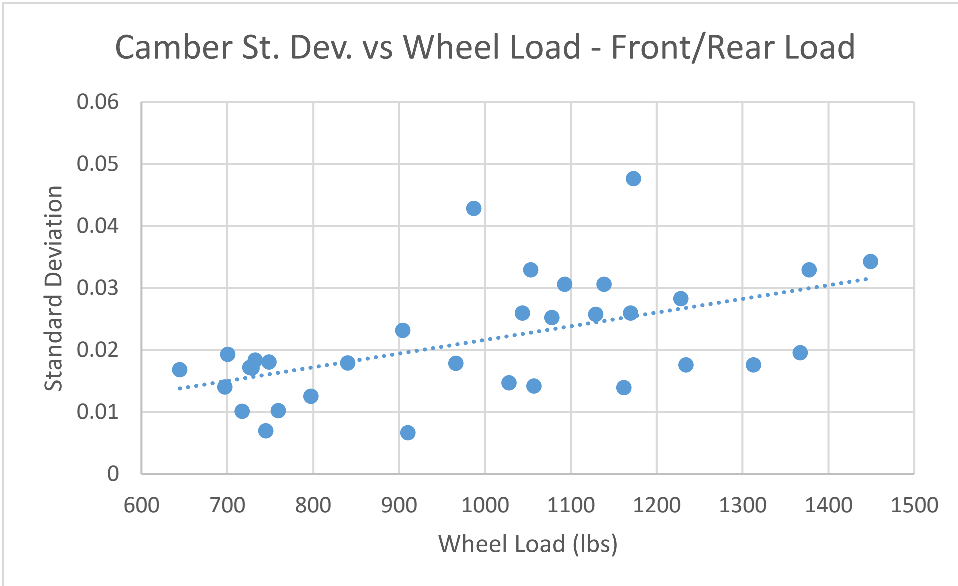


Figure 59: Trend Plot – Camber St. Dev. vs Wheel Load (F&Rr load)

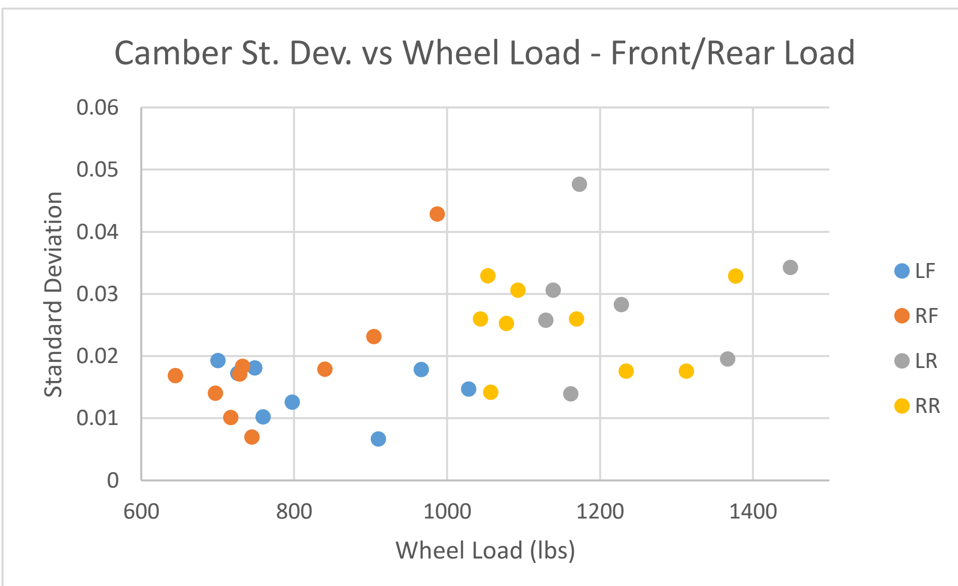


Figure 60: Individual Wheel Plot – Camber St. Dev. vs Wheel Load (F&Rr load)

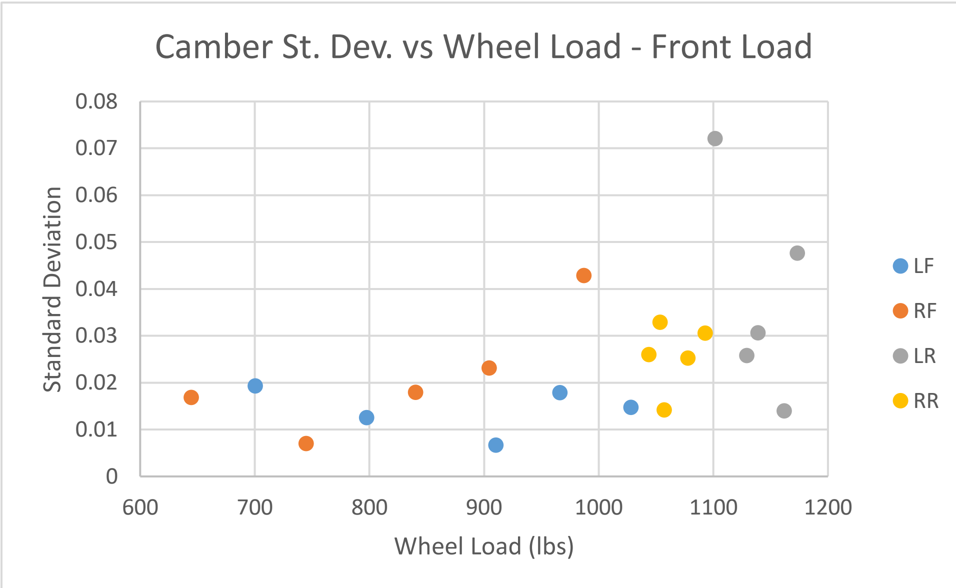


Figure 61: Individual Wheel Plot – Camber St. Dev. vs Wheel Load (F load)

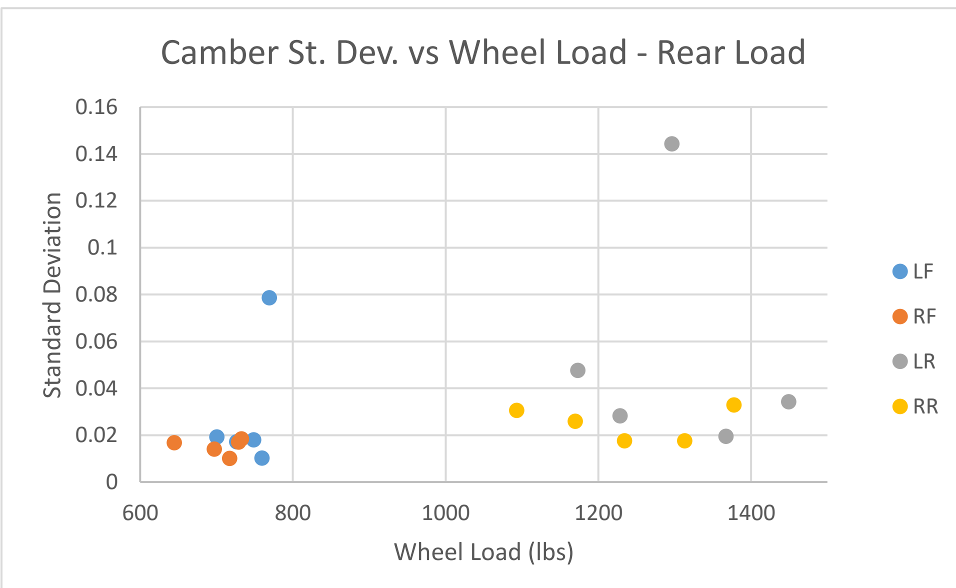


Figure 62: Individual Wheel Plot – Camber St. Dev. vs Wheel Load (Rr load)

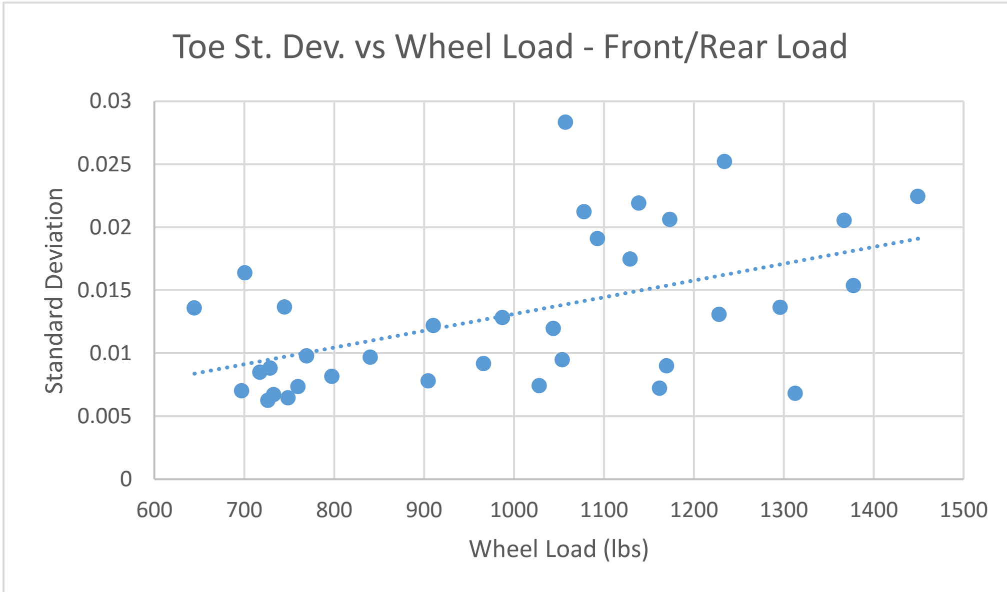


Figure 63: Trend Plot – Toe St. Dev. vs Wheel Load (F&Rr load)

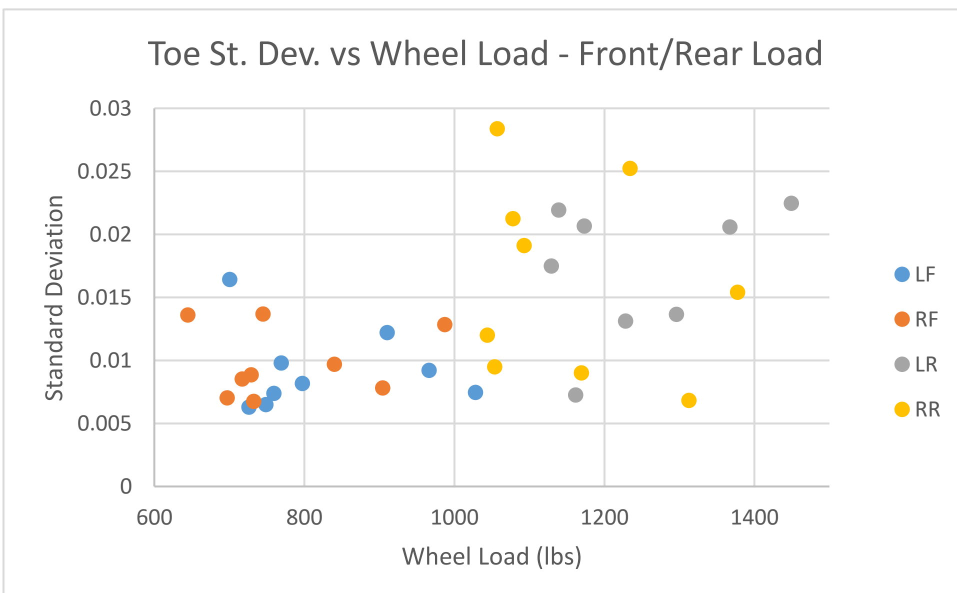


Figure 64: Individual Wheel Plot – Toe St. Dev. vs Wheel Load (F&Rr load)

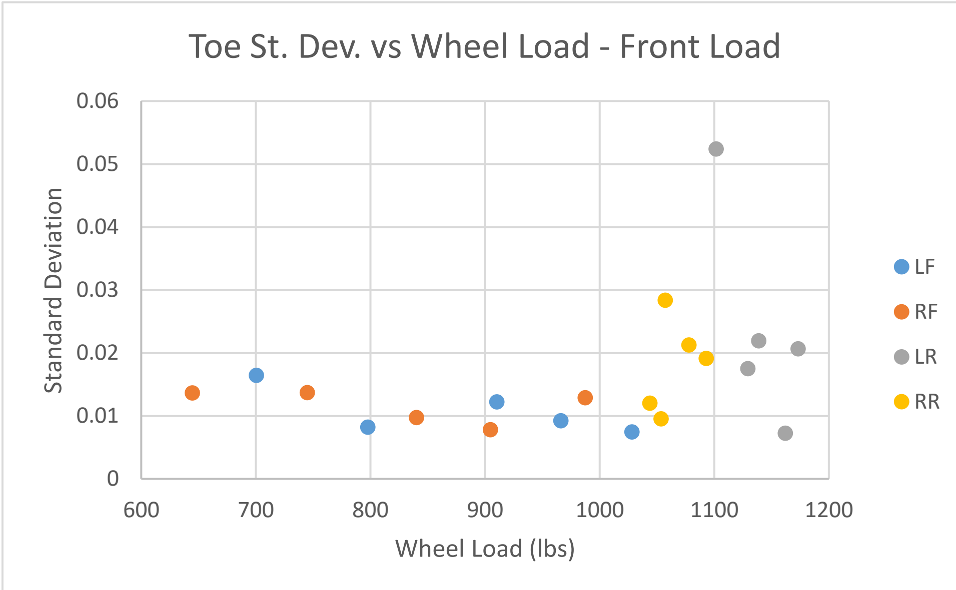


Figure 65: Individual Wheel Plot – Toe St. Dev. vs Wheel Load (F load)

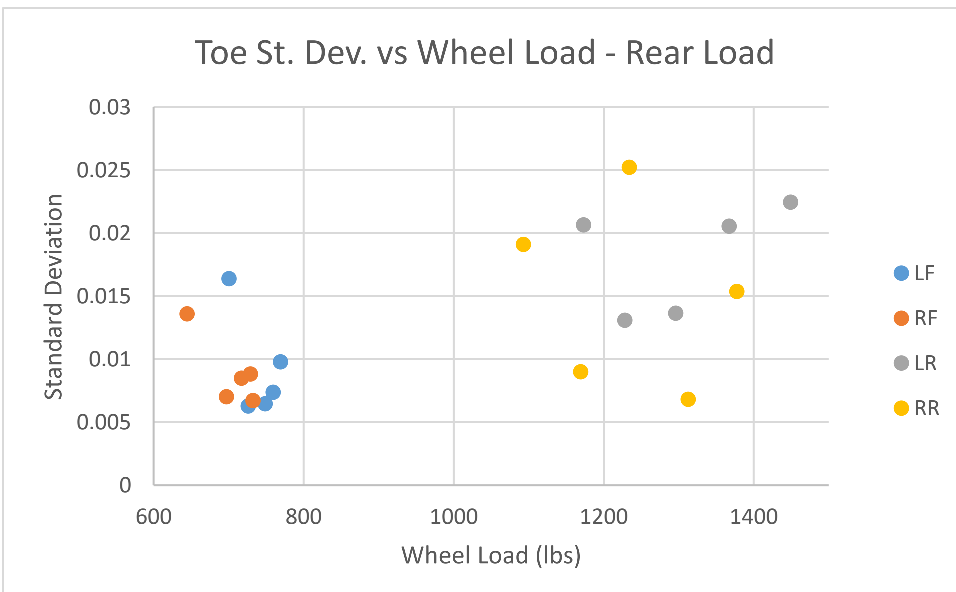


Figure 66: Individual Wheel Plot – Toe St. Dev. vs Wheel Load (Rr load)

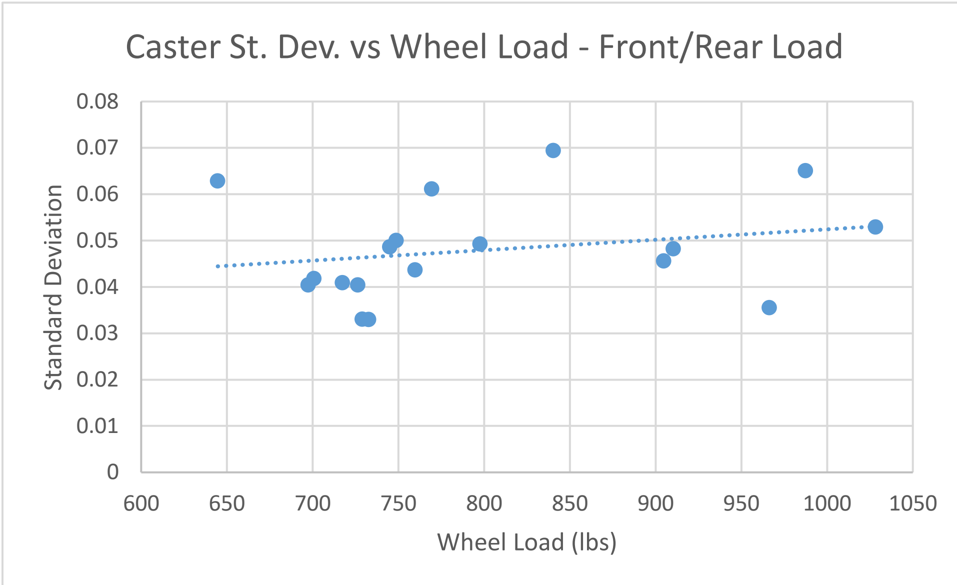


Figure 67: Trend Plot – Caster St. Dev. vs Wheel Load (F&Rr load)

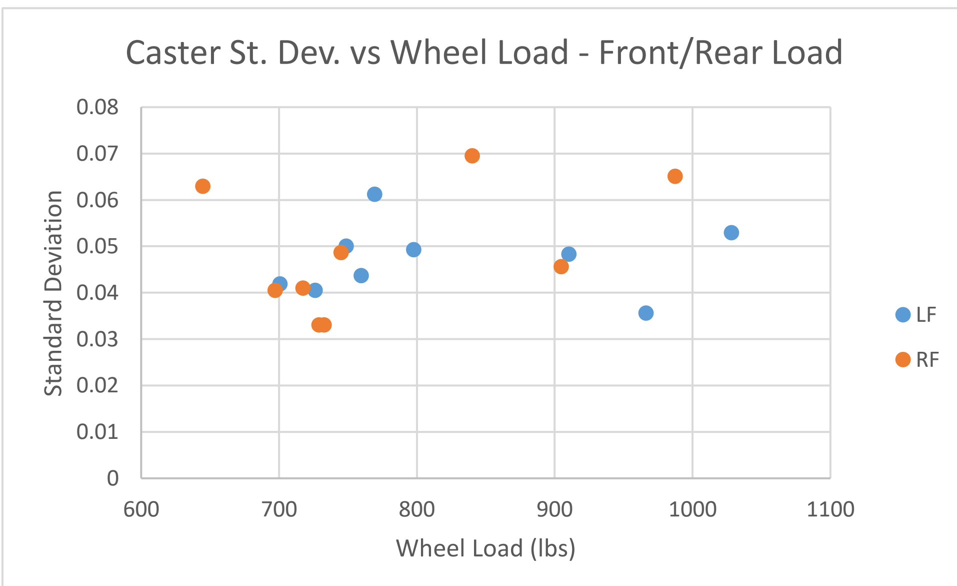


Figure 68: Individual Wheel Plot – Caster St. Dev. vs Wheel Load (F&Rr load)

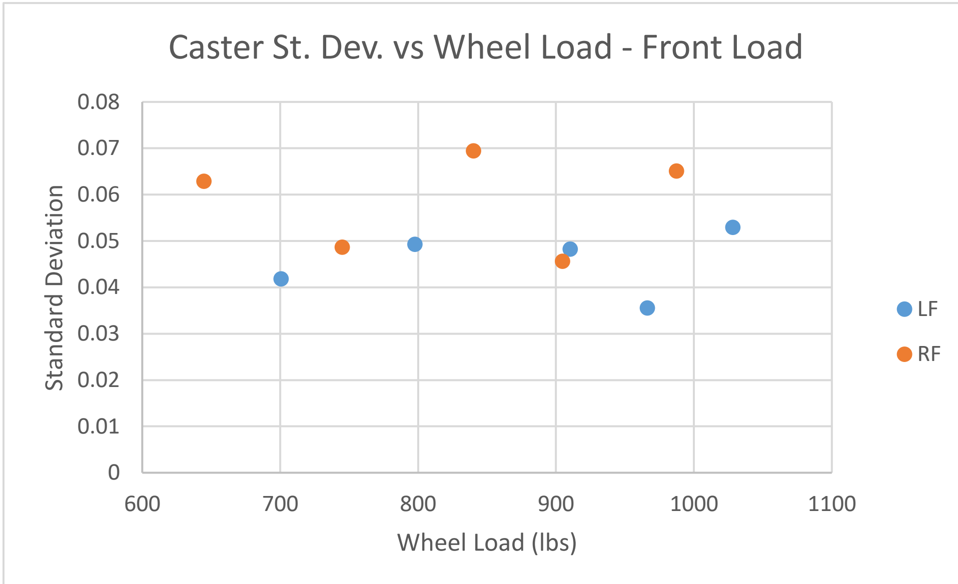


Figure 69: Individual Wheel Plot – Caster St. Dev. vs Wheel Load (F load)

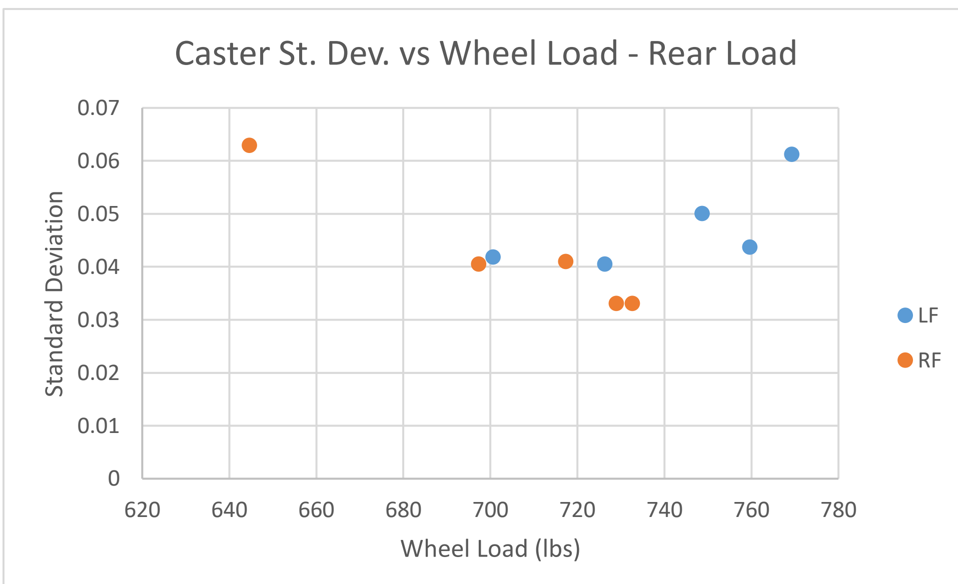


Figure 70: Individual Wheel Plot – Caster St. Dev. vs Wheel Load (Rr load)

All trend plots and supplementary plots are shown above. Summary plots for camber, toe, and caster are shown below.

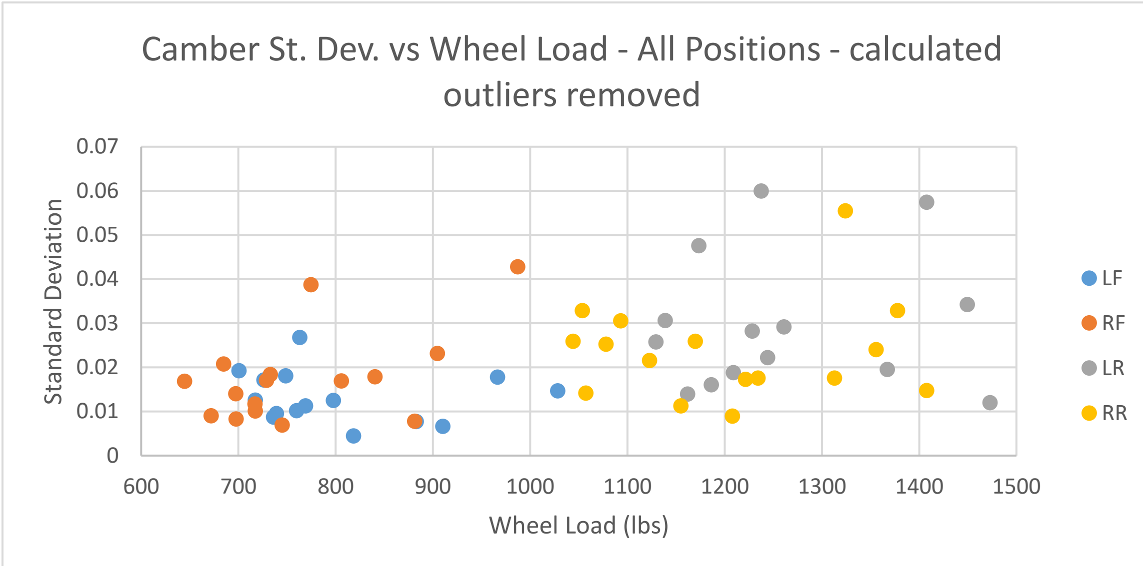


Figure 71: Summary Plot – Camber St. Dev. vs Wheel Load

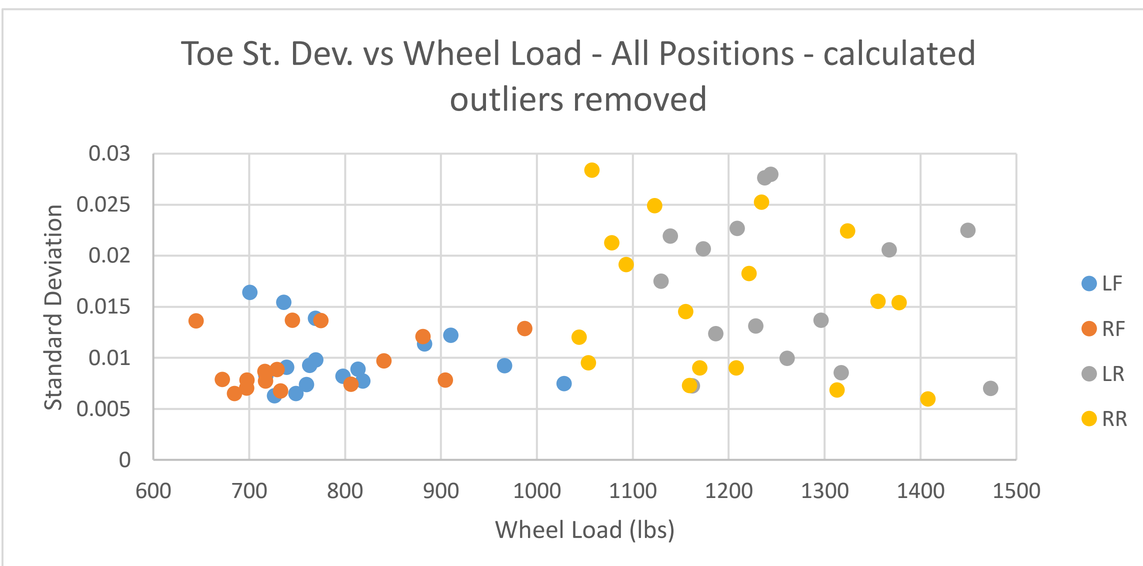


Figure 72: Summary Plot – Toe St. Dev. vs Wheel Load

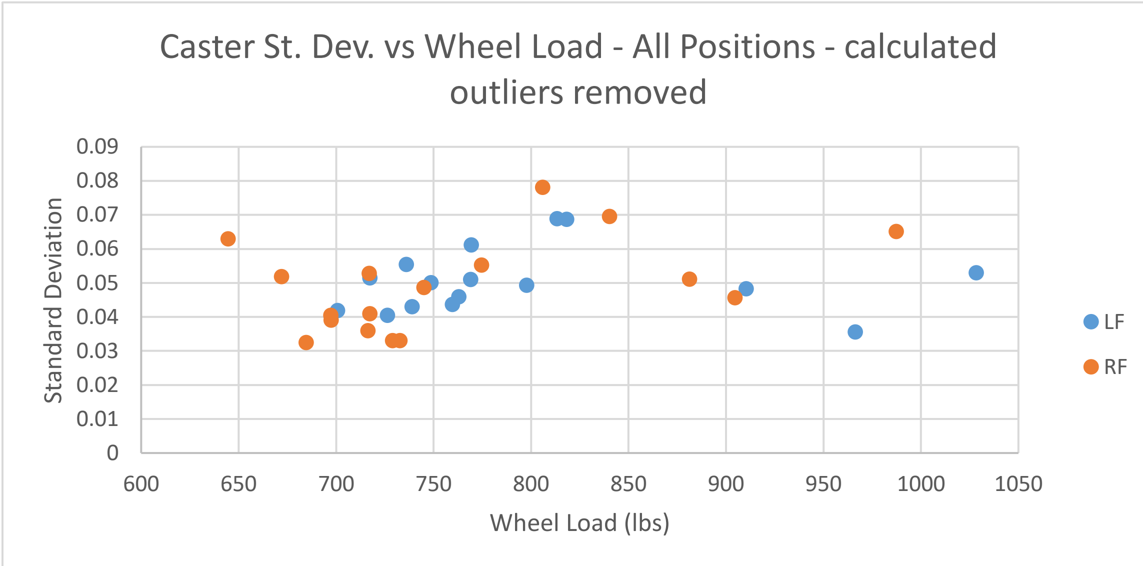


Figure 73: Summary Plot – Caster St. Dev. vs Wheel Load

While there are many plots for load magnitude influences, the key plots to look at are trend plots, the first plot following a trend plot, and all summary plots.

Observation 2: Influence of Load Position

Load position plots show the same information as load magnitude summary plots. The difference between them is the legend subject. Rather than looking at individual wheels, load position is the topic of interest.

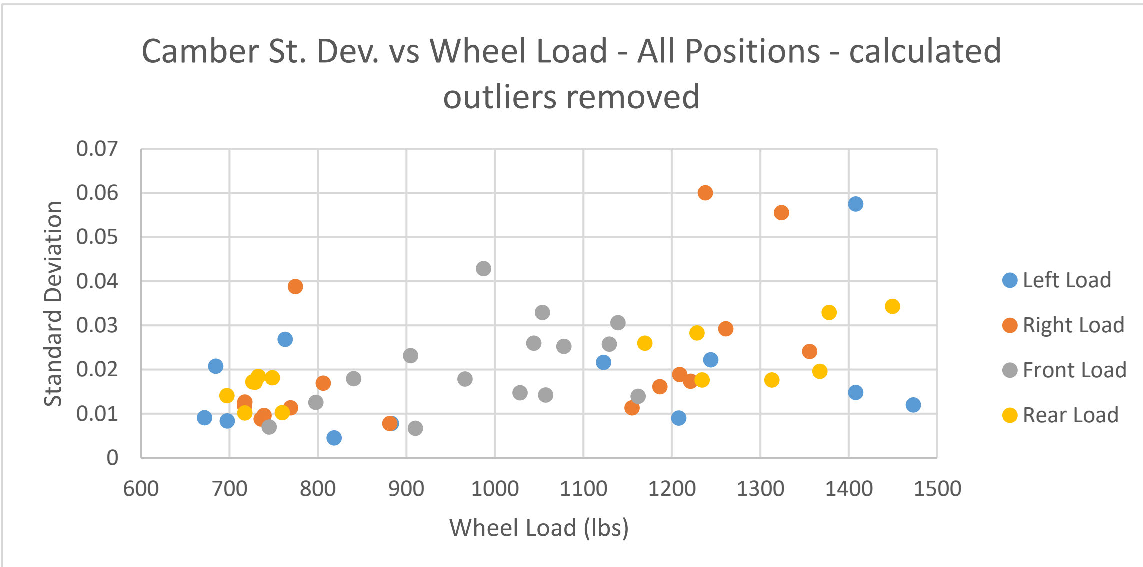


Figure 74: Load Position Plot – Camber St. Dev. vs Wheel Load

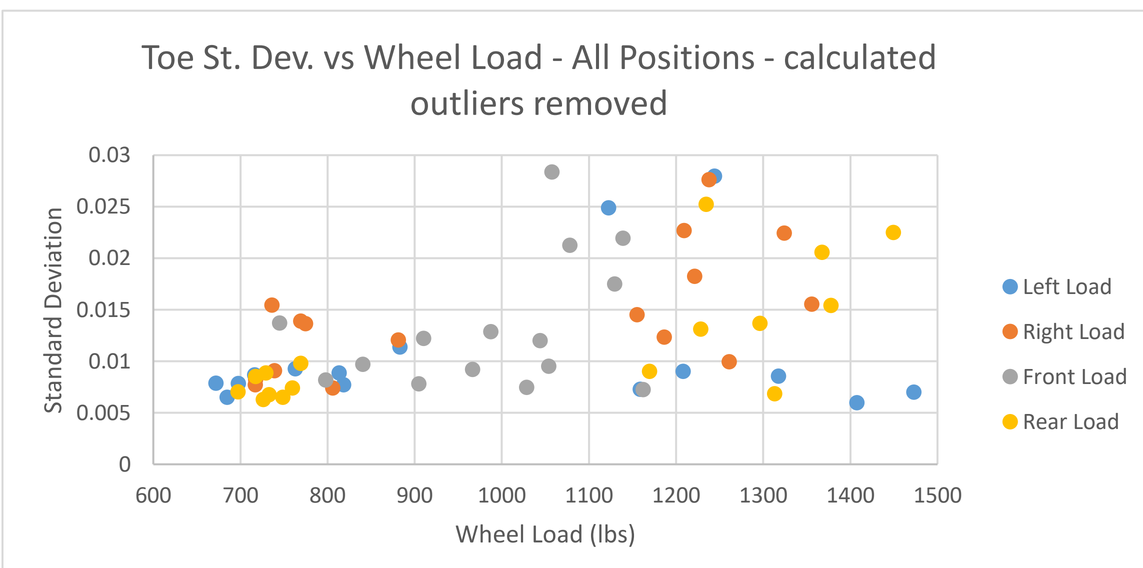


Figure 75: Load Position Plot – Toe St. Dev. vs Wheel Load

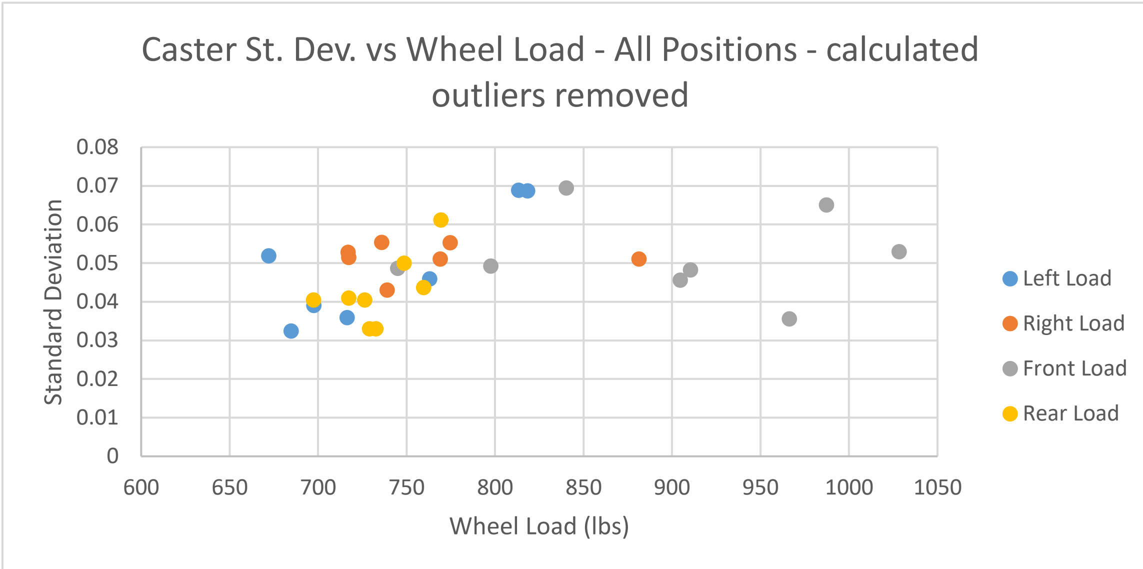


Figure 76: Load Position Plot – Caster St. Dev. vs Wheel Load

4.3 Current K&C Results

Currently, Sagar has created comparisons of camber and toe with K&C data for the front and rear loads. Each plot combines the front and rear cases to achieve one curve for experimental data. For ease of interpretation, each figure is comprised of four plots. Both figures show plots which represent the LF, RF, LR, and RR wheel in that order. As one can tell from Figures 77 and 78, our wheel alignment data has a many similarities to K&C data in regards to camber and toe for longitudinal loads. Our experimental data seems to better match K&C camber results than it does for K&C toe results though. For a detailed analysis of this, please read Sagar's thesis paper on this topic.

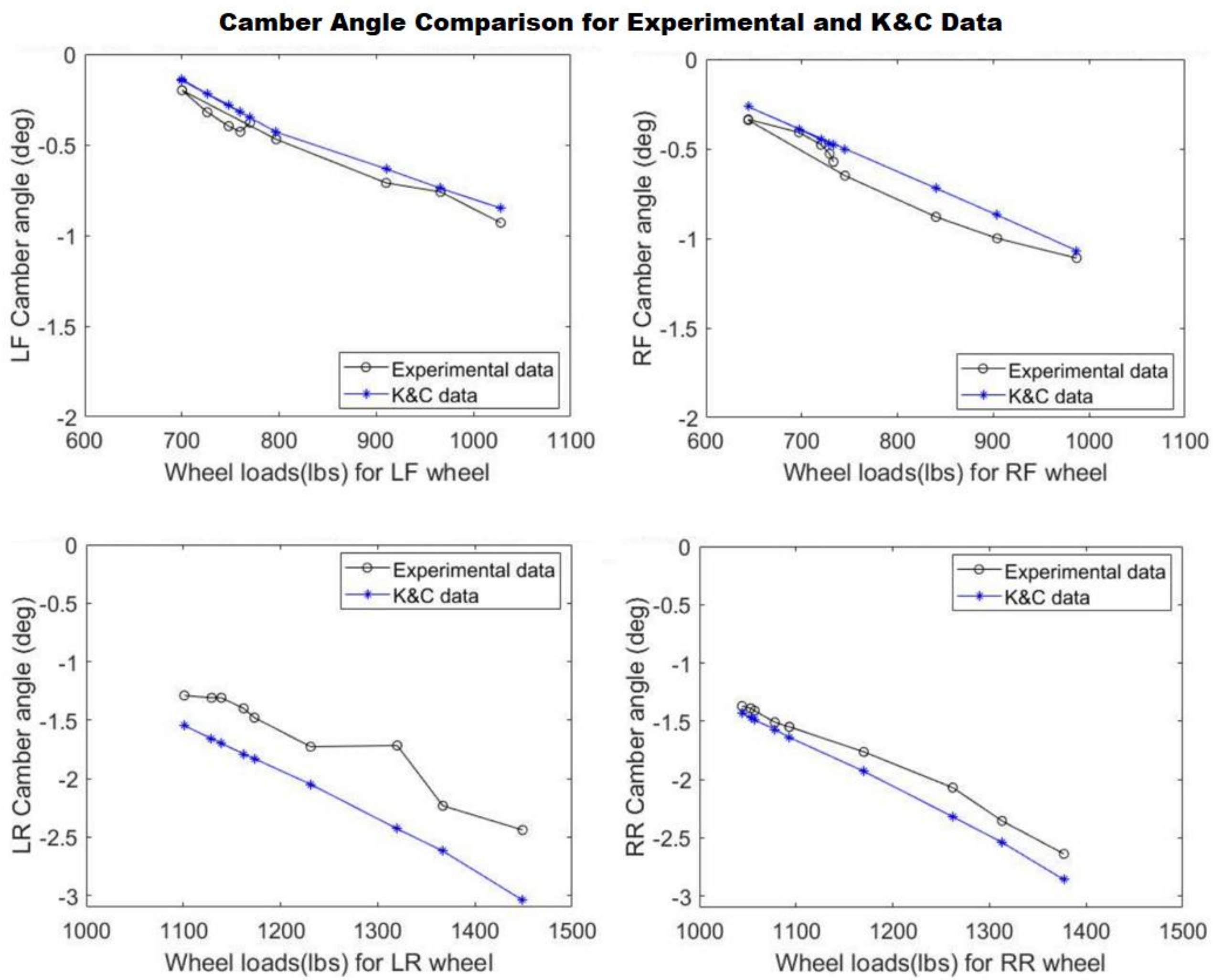


Figure 77: Camber Trend - Experimental vs K&C (Front & Rear Loads)

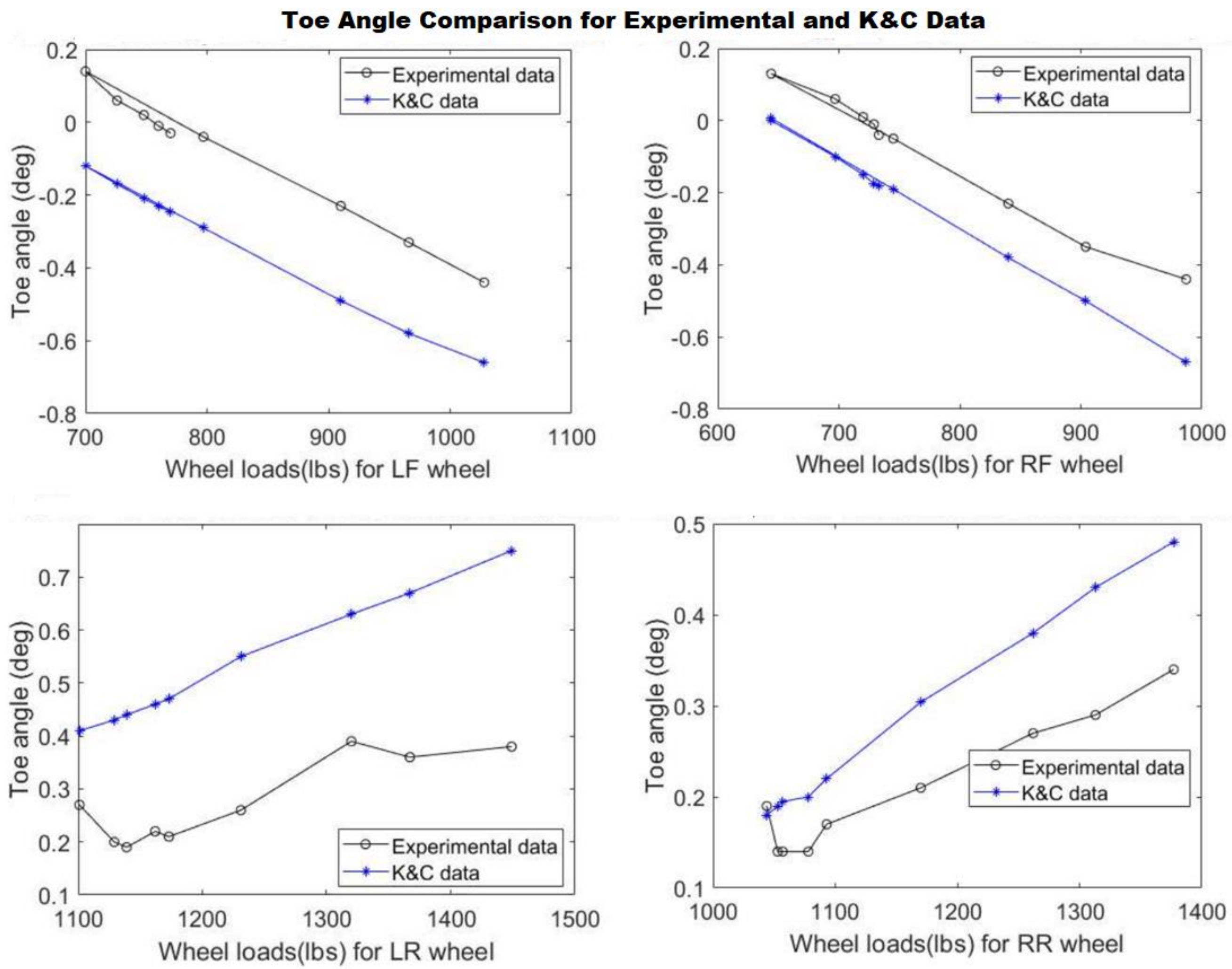


Figure 78: Toe Trend - Experimental vs K&C (Front & Rear Loads)

CHAPTER 5: DISCUSSION

5.1 Measurement Trends with Wheel Load

While there are many plots in the section 4.2 of the Results chapter, the discussion in regards to them will primarily be separated into three categories. The first is for Figures 35 through 46, the second is for Figures 47 through 73, and third is for Figures 74 through 76. By looking at the averaged measurement values versus wheel load (Figures 35-46), a few inferences can be made.

- Camber:
    - As wheel load increases, camber values tend to become more negative. If load continues to increase on a given side of a vehicle, wheels on the same side eventually start to increase in camber value.
- Toe:
    - When wheel load increases, toe tends to decrease (toe-out) in the front suspension and toe tends to increase (toe-in) in the rear suspension.
- Caster:
    - As wheel load increases due to a front suspension load, caster value decreases. As wheel load increase due to a rear suspension load, caster value increases.

These match what would theoretically occur if a vehicle was put under load. One should note that in the lateral cases, the vehicle eventually experiences roll even though individual wheel load increases across all wheels. This is why the inner wheels eventually start to increase in camber. Similarly with caster, in both cases of load (front & rear), wheel load increases but different caster trends are noticeable. This is due to the vehicle rolling forward or backward depending on the load case. By looking at all of these plots (Figures 35-46), an interesting note is that the longitudinal (front and rear) loads created better measurement trends than the lateral (left and right) loads. The longitudinal load plots for the most part have traditional trends (being either linear, logarithmic decay, exponential, or exponential decay). The lateral load cases seem to be more prone to having wavy trends. This brings up the concern that wheel load data may have been entered incorrectly within the lateral cases. This is discussed further within section 5.5.

5.2 Influence of Load Magnitude on Wheel Alignment Variability

Because of the similar trend shapes that each lateral load creates, they are paired within Observation 1 and 2 of section 4.2. The longitudinal loads are also paired since they share similar trend shapes. Within Figures 47 – 73, the key plots to look at are trend plots, the first plot following a trend plot, and all summary plots. By looking at any trend plot, with the exception of caster, there is a strong correlation between wheel load and standard deviation. While the caster trend lines do technically increase in standard deviation with wheel load according to these plots, the slope is rather gentle and the data does not support the trend as strong as it does for camber and toe. These trend plots alone conclude that camber and toe measurements become more susceptible to variability as wheel load increases. By looking at the supplementary plots afterward, a different conclusion can be made. For example, look at Figures 59 and 60. This combines the front and rear load cases for camber standard deviation. By looking at Figure 59, one might conclude that camber standard deviation increases with increasing wheel load. By looking at Figure 60, each point is now identified as a specific wheel. One takeaway is that the rear wheels are much more susceptible to variability than the front wheels.

Another takeaway is that the rear wheels are always experiencing a larger amount of load than the front wheels. These observations are the same for all load cases and measurements with the exception of caster since it can only be observed on the front suspension. If one were to look at both the front and the rear suspension of Figure 60 individually, the conclusion of camber variability increasing with wheel load would be false. Two additional figures are created below to illustrate that conclusion.

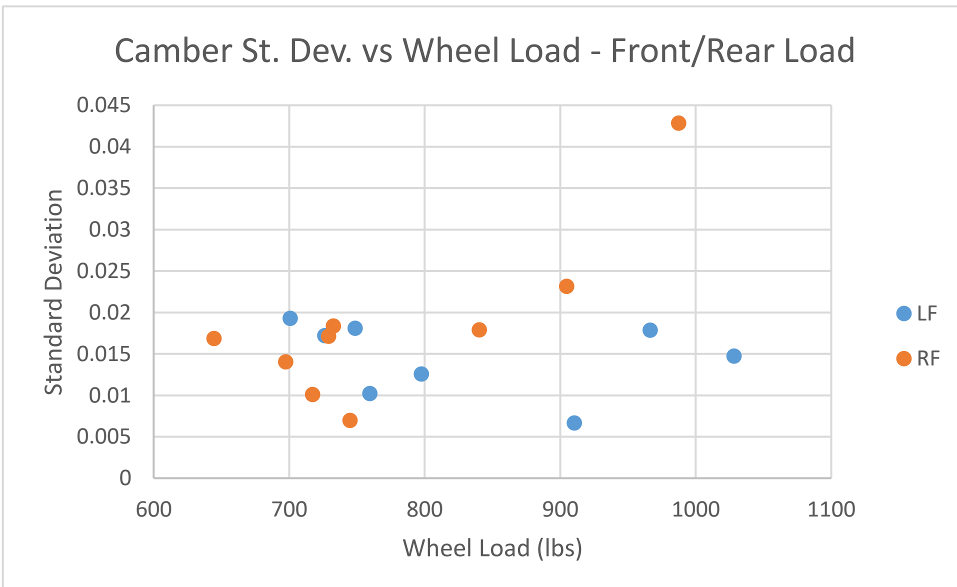


Figure 79: Camber St. Dev. vs Wheel Load (F&Rr Load) – Front Suspension

Within Figures 79 and 80, camber values do not become more susceptible to variability with an increase in wheel load. This same analysis can be done for the front and rear loads of toe, the left and right loads of camber, and the left and right loads of toe. Since caster only happens about the front suspension, this can be analyzed individually about front and rear loads and about left and right loads. The same conclusion is found for all analyses. This means that wheel load magnitude does not influence wheel alignment variability.

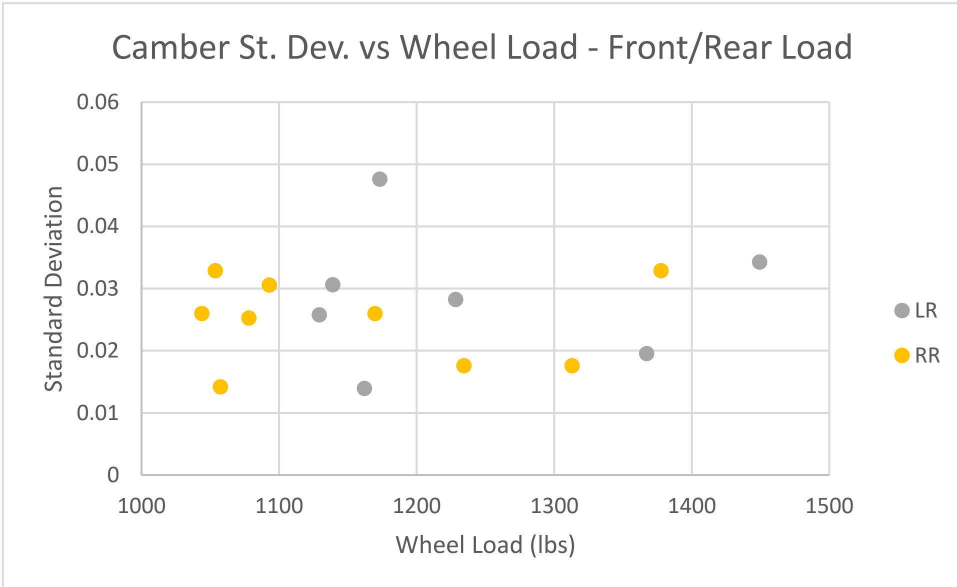


Figure 80: Camber St. Dev. vs Wheel Load (F&Rr Load) – Rear Suspension

5.3 Influence of Load Position on Wheel Alignment Variability

Figures 74 through 76 show how load position affects variability of camber, toe, and caster respectively. While these graphs share the same data points as the summary plots of the load magnitude results, the different legend shows a different type of result. Rather than focusing on the x-axis (which is wheel load magnitude), attention is brought to the legend key and the y-axis (standard deviation) only. The analysis goal is to discover if one type of load (individual, lateral, or longitudinal) creates more variability in wheel alignment measurements than other load types. Between all measurement types (camber, toe, and caster), there is no load type which creates a difference in standard deviation compared to other loads. This means that load position also is not an influencing factor of wheel alignment variability.

5.4 Suspension Analysis

Even though both variables resulted in no influence in regards to wheel alignment variability, it is still necessary to explain why the front and rear suspensions act the way they do within Figures 47 through 73. The reason the rear suspension always experiences higher levels of wheel load than the front suspension, no matter what load case is being applied, is simply because the Porsche 911 is a rear engine car. The engine on a Porsche 911 sits just behind the rear wheels. This explains why higher values of load are always observed on the rear suspension.

The reason the front suspension always has a lower level of standard deviation than the rear suspension is because the front and rear suspensions are different. The front wheels on a 1999 Porsche Carrera 911 use a MacPherson strut. A MacPherson strut suspension is comprised of a damper/spring assembly, a steering knuckle, a steering rod, and a single lower control arm. The top portion of the damper and spring assembly is fixed to the frame of the vehicle while the bottom portion is fixed to the steering knuckle.

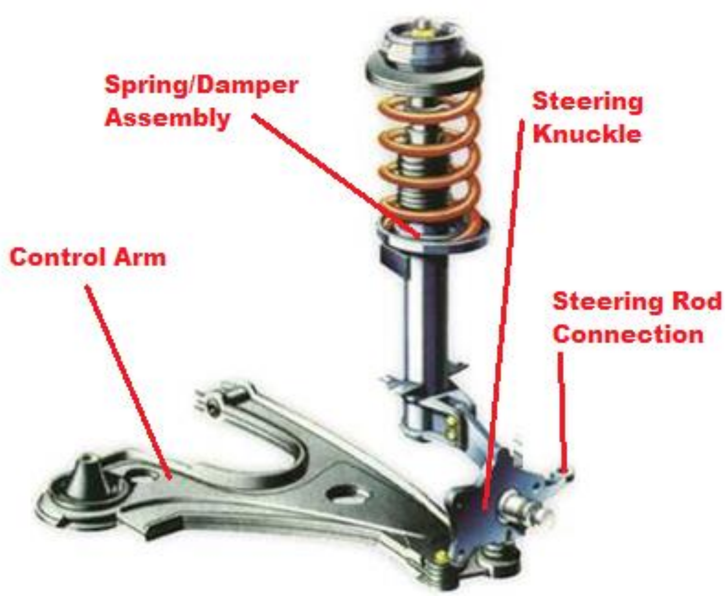


Figure 81: MacPherson Strut Anatomy (Lot, R.)

The lower control arm connects to the frame via two hinges and connects to the steering knuckle with the use of a ball-joint (also known as a three-point link). The purpose of using a ball joint is to allow for the suspension to travel along the strut axis but also to allow for steering motion of the wheels.

The rear suspension on a 1999 Porsche Carrera 911 uses a five link suspension, also known as a multi-link suspension. The easiest way to picture this is to imagine an independent suspension comprised of two three-point links. Since a three-point link is equivalent to two two-point links ("Axles and Suspensions."), these three-point links are replaced with two-point links. This leads to a total of four two-point links, two above the axle and two below. The fifth two-point link is attached as a toe link. The purpose of having individual links is for the manufacturer to better tune the vehicle's suspension for its intended purpose. Each two-point link in this suspension is connected with the use of bushings rather than ball joints. The ball joint, seen in the independent front suspensions, is very hard and does not offer room for play other than its intended swivel motions. The bushings, however, are relatively soft in comparison. This is why variability in regards to wheel alignment measurements is noticeably higher in the rear suspension than the front suspension.

5.5 Possible and Known Errors

To figure out what potential mistakes were made in this experiment, the following analysis is done. Section 5.1 brought wheel load to my attention after noting that lateral load measurements had some untraditional trends. Table 8 shows all individual wheel loads with sums calculated for each case set. There are three measurement sets for each case. A secondary table is made from this to verify if load is added correctly for each case. The values are calculated from the third set of data (second set for Left 600).

Table 8: Individual Wheel Load Analysis

	LF	RF	LR	RR	LF	RF	LR	RR	LF	RF	LR	RR
Base	712	630	1184	1076	692	659	1169	1099	698	645	1167	1104
				3602				3619				3614
Left 150	765	680	1242	1125	760	688	1254	1116	764	686	1236	1127
				3812				3818				3813
Left 300	821	715	1311	1158	804	721	1324	1158	815	713	1317	1161
				4005				4007				4006
Left 450	821	667	1408	1198	818	674	1408	1196	816	675	1407	1197
				4094				4096				4095
Left 600	877	703	1455	1221	889	692	1491	1195				
				4256				4267				
Right 150	716	728	1173	1151	725	708	1187	1159	711	715	1199	1155
				3768				3779				3780
Right 300	733	776	1217	1227	746	779	1203	1206	729	769	1207	1231
				3953				3934				3936
Right 450	740	810	1238	1311	745	790	1230	1348	732	818	1245	1313
				4099				4113				4108
Right 600	767	882	1260	1358	771	881	1255	1359	769	881	1268	1350
				4267				4266				4268
Front 150	795	747	1163	1078	798	747	1163	1077	800	741	1160	1079
				3783				3785				3780
Front 300	910	840	1131	1061	913	842	1137	1060	908	839	1149	1051
				3942				3952				3947
Front 400	979	892	1135	1049	958	913	1123	1059	962	909	1130	1053
				4055				4053				4054
Front 500	1028	978	1116	1044	1026	988	1110	1038	1031	996	1079	1050
				4166				4162				4156
Rear 150	728	697	1221	1175	727	698	1233	1160	724	697	1231	1174
				3821				3818				3826
Rear 300	750	716	1298	1234	750	721	1288	1234	746	715	1303	1235
				3998				3993				3999
Rear 450	758	726	1369	1317	746	734	1378	1308	775	727	1355	1314
				4170				4166				4171
Rear 600	763	736	1453	1381	768	737	1452	1376	777	725	1443	1376
				4333				4333				4321

The blue values from Table 8 represent totals that differ their equivalent load sets by more than 10 lbs. These are highlighted because technically each set of three should have equivalent load totals. Slight differences in load total can occur due to driver weight shift, variations within how the platforms sit on the stopping wedges, and accuracy tolerance of the wheel scales. More than likely, these measurement variations are due to human error. The target driver weight is to be 180 lbs. As mentioned earlier, an additional 20 lb. steel bar was added to the driver foot-well when I steered the car in order to meet

180 lbs. There is a possibility that the additional steel bar was accidentally omitted during one Base, one Right 150 and one Right 450 case. Similarly, there is a possibility that the steel bar was accidentally kept in if Sagar was weighed during one Right 300 case. This would explain the 9 lb. to 19 lb. shift.

Another important mention is that the left front wheel experiences no change in load from the Left 300 to Left 450 case (first set only). This was first thought to be a manual input error. Even though this is a strange phenomenon, this shouldn't be an error because the total values across all sets of the Left 300 and Left 450 case have relatively similar values.

Table 9: Individual Wheel Load Differences

	Increase in Weight from Base	Difference between Adjacent Cases
Base	0	
Left 150	199	
		193
Left 300	392	
		89
Left 450	481	
		167
Left 600	648	
Right 150	166	
		156
Right 300	322	
		172
Right 450	494	
		160
Right 600	654	
Front 150	166	
		167
Front 300	333	
		107
Front 400	440	
		102
Front 500	542	
Rear 150	212	
		173
Rear 300	385	
		172
Rear 450	557	
		150
Rear 600	707	

The red values in Table 9 represent unpredicted results in regards to weight. The first concern in regards to Table 9 is The Left 150 load value. This reads 49 lbs. over the stated amount. As one can tell by looking at the third column, all accepted increases in weight are slightly over the initial stated amount (100 lbs. or 150 lbs. depending on the case). This is expected since all sandbags will differ slightly in weight. Because the Left 150 load shows an increase less than that of an average sandbag, this is thought to just be an anomaly. Since weight is added in an accepted value for the next case (Left 300), the additional 49 lbs. transfers over and the case looks like it also has unpredicted results. The next unpredicted result is the 89 lb. difference between Left 300 and Left 450. By looking at all sets of Left 300 and Left 450 from Table 8, it looks like only two sandbags were added rather than three. The third and final experimental mistake corresponds to the rear load case. The issue lies with the Rear 150 case. Since load difference between all rear load cases is spot on, this makes the subsequent cases appear unpredicted. When Sagar and I conducted wheel alignments, we did them in the following order: Base, Front, Right, Rear, and Left. In the right load case, the final weight set had a sandbag in the front trunk. Once this set was finished, we prepared the car for the rear load case by removing all sandbags. Unfortunately we forgot the one sandbag that was still in the trunk. The sandbag was discovered near the last few sets of the rear load case. This case was to be revisited if time was available after the left load case. This explains why there is a rough additional 50 lbs. in the Rear 150 case.

Below summarizes all potential and known experimental mistakes. Possible omission or addition of a 20 lb. bar weight may attribute to variations in total weight ranging from 9 to 19 lbs. in four load cases. The first known mistake is that only two sandbags were added in the Left 450 case from the Left 300 case. The second known mistake is that one sandbag was accidentally left in the front trunk during the rear load cases.

At a maximum consequence of these mistakes, a quarter (all rear cases and Left 450) of the data points will shift by less than 50 lbs. Fortunately, the range of data covers close to 600 to 1500 lbs. with 62 points in camber, 70 points in toe and 34 points in caster not including outliers. Because there are so many values and the range is so large, these slight shifts should not affect general trends.

To link this back into the results of Figures 35 through 46, the unpredicted results do not explain the wavy trends of lateral loads versus the traditional trends of longitudinal loads.

One more fault needs to be addressed in regards to this experiment. This fault explains why there are only 11 measurements for the Left 600 case. With all mechanical systems, maintenance is a necessary burden. Sagar and I did not take maintenance into account when we conducted wheel alignment measurements on the four-post lift. An excess of nearly 500 lifts is very demanding for the four-post. This led to a pulley bolt bending underneath the right platform. The bend prevented two pulleys from rotating about that bolt. This must have caused excessive friction on one of the cables. We believe this friction is the cause for a cable snapping. If I routinely checked on the condition of the four-post lifting components, this could have been caught early and would have prevented this level of damage. The cable snapped during a lift attempt when the platforms were still resting on the stopping wedges. This prevented the platforms (and the car) from falling as soon as the cable snapped. This left the car stuck on the platforms about four feet off of the ground. After this incident, measurements were brought to a halt. The area was cleared and Luke Woroniecki was able to lift the Porsche 911 off of the four-post lift and bring it to the floor safely with a forklift. As of right now, the four-post lift is still stuck on the stopping wedges and I am working with a third party for replacing cables and components on the lift. To reiterate my mistake, I should have looked after the four-post better and I share the blame for its failure in regards to a cable snap.

Figure 82: Cable Snap

Figure 83: Bent Pulley Bolt

Figure 84: Luke Saves the Porsche

CHAPTER 6: CONCLUSION

As wheel alignment measurements including caster sweeps are conducted on a vehicle, levels of standard deviation can be observed when comparing multiple wheel alignment results. This observation led to the study of measuring if wheel load magnitude and load position would influence variability in wheel alignment measurements. In order to produce an accurate result, a large quantity of measurements would need to be taken. This sparked the idea of creating a new wheel alignment apparatus which would allow for faster subsequent measurements. The new system decreased time to an average 2.8 minutes in-between each wheel alignment result, compared to the previous averaged 4.33 minutes. After numerous measurements and a thorough analysis, I found that neither wheel load magnitude nor load position influence wheel alignment variability. By shifting focus to the configuration of the test car, experimental results point to suspension geometry as a dictating factor in wheel alignment variability. The test vehicle (a 1999 Porsche Carrera 911) uses MacPherson struts in the front and a multi-link suspension in the rear. The MacPherson strut uses a ball-joint as its main connection between the steering knuckle and the control arm. Rather than using control arms on a multi-link suspension, two-point links are used. Every two-point link is connected with the use of a bushing. Since bushings, in the rear suspension, are much softer than the ball-joint used in the front suspension, the rear suspension always shows higher levels of variability in regards to camber and caster. For future experiments, suspension geometry configuration should be taken into consideration before new variables are tested. While there may be other influencing factors, it is safe to say that neither load magnitude nor load position influence wheel alignment variability.

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APPENDIX

Below shows all raw data inputted into the initial Excel sheet. Blank navy blue values represent data that the Hunter system did not collect. Each row shows an individual measurement.

	LF				RF				LR			RR			Front			Rear	
Load Pos.	Camber	Caster	Toe	Load Val	Camber	Caster	Toe	Load Val	Camber	Toe	Load Val	Camber	Toe	Load Val	Cros Cam	Cros Cas	Tot Toe	Tot Toe	Thrst Ang
Base	-0.19	7.99	0.17	712	-0.37	7.83	0.14	630	-1.47	0.21	1184	-1.6	0.11	1076	0.18	0.16	0.31	0.32	0.05
Base	-0.21	7.87	0.16	712	-0.35	7.72	0.16	630	-1.39	0.22	1184	-1.6	0.14	1076	0.14	0.15	0.32	0.36	0.04
Base	-0.19	7.82	0.17	712	-0.37	7.66	0.15	630	-1.45	0.23	1184	-1.58	0.15	1076	0.18	0.16	0.31	0.37	0.04
Base	-0.17	7.88	0.15	712	-0.36	7.72	0.16	630	-1.45	0.24	1184	-1.56	0.15	1076	0.18	0.16	0.32	0.39	0.04
Base	-0.32	7.74	0.17	712	-0.19	7.71	0.15	630	-1.62	0.23	1184	-1.35	0.19	1076	-0.12	3	0.32	0.4	0.02
Base	-0.18	7.85	0.17	712	-0.35	7.75	0.14	630	-1.47	0.25	1184	-1.58	0.14	1076	0.17	0.1	0.31	0.38	0.06
Base	-0.21	7.75	0.15	712	-0.35	7.76	0.14	630	-1.49	0.26	1184	-1.52	0.1	1076	0.14	-0.02	0.29	0.36	0.08
Base	-0.23	7.83	0.15	712	-0.32	7.72	0.13	630	-1.54	0.24	1184	-1.5	0.11	1076	0.1	0.11	0.29	0.35	0.07
Base	-0.2	7.89	0.15	712	-0.33	7.57	0.13	630	-1.38	0.2	1184	-1.52	0.19	1076	0.13	0.32	0.28	0.39	0.01
Base	-0.18	7.76	0.14	712	-0.34	7.49	0.14	630	-1.4	0.22	1184	-1.57	0.19	1076	0.16	0.27	0.28	0.41	0.02
Base	-0.19	7.86	0.13	692	-0.35	7.67	0.13	659	-1.45	0.23	1169	-1.55	0.16	1099	0.16	0.19	0.25	0.39	0.03
Base	-0.2	7.89	0.15	692	-0.34	7.65	0.11	659	-1.44	0.22	1169	-1.55	0.17	1099	0.14	0.24	0.25	0.39	0.03
Base	-0.2	7.87	0.13	692	-0.34	7.71	0.12	659	-1.45	0.23	1169	-1.59	0.16	1099	0.14	0.16	0.25	0.39	0.03
Base	-0.19	7.93	0.13	692	-0.36	7.62	0.13	659	-1.46	0.23	1169	-1.57	0.18	1099	0.16	0.3	0.26	0.4	0.03
Base	-0.2	7.85	0.13	692	-0.35	7.56	0.13	659	-1.47	0.22	1169	-1.57	0.18	1099	0.16	0.29	0.26	0.41	0.02
Base	-0.2	7.83	0.17	692	-0.36	7.62	0.1	659	-1.49	0.2	1169	-1.57	0.18	1099	0.16	0.22	0.26	0.37	0.01
Base	-0.22	7.84	0.13	692	-0.35	7.67	0.13	659	-1.54	0.22	1169	-1.55	0.17	1099	0.13	0.18	0.26	0.39	0.03
Base	-0.23	7.83	0.13	692	-0.42	7.7	0.13	659	-1.53	0.22	1169	-1.52	0.16	1099	0.19	0.14	0.26	0.38	0.03
Base	-0.24	7.84	0.14	692	-0.34	7.64	0.12	659	-1.51	0.22	1169	-1.5	0.19	1099	0.11	0.2	0.26	0.4	0.02
Base	-0.18	7.91	0.14	692	-0.31	7.66	0.13	659	-1.5	0.22	1169	-1.49	0.18	1099	0.13	0.25	0.27	0.4	0.02
Base	-0.17	7.88	0.14	698	-0.33	7.67	0.15	645	-1.48	0.22	1167	-1.53	0.22	1104	0.16	0.21	0.29	0.43	0
Base	-0.18	7.85	0.15	698	-0.34	7.72	0.14	645	-1.49	0.19	1167	-1.56	0.21	1104	0.17	0.13	0.29	0.4	-0.01
Base	-0.18	7.87	0.15	698	-0.33	7.61	0.13	645	-1.53	0.18	1167	-1.57	0.19	1104	0.15	0.26	0.28	0.37	-0.01
Base	-0.18	7.72	0.15	698	-0.32	7.74	0.13	645	-1.58	0.2	1167	-1.54	0.17	1104	0.14	-0.02	0.27	0.37	0.01
Base	-0.13	7.93	0.09	698	-0.32	7.82	0.18	645	-1.55	0.22	1167	-1.53	0.16	1104	0.2	0.11	0.28	0.38	0.03
Base	-0.21	7.84	0.13	698	-0.35	7.7	0.12	645	-1.46	0.17	1167	-1.54	0.16	1104	0.14	0.15	0.24	0.34	0.01
Base	-0.21	7.87	0.14	698	-0.32	7.67	0.12	645	-1.51	0.18	1167	-1.55	0.17	1104	0.11	0.2	0.27	0.35	0.01
Base	-0.17	7.86	0.1	698	-0.37	7.69	0.14	645	-1.45	0.17	1167	-1.6	0.18	1104	0.19	0.17	0.24	0.35	0
Base	-0.26	7.91	0.14	698	-0.23	7.65	0.12	645	-1.43	0.18	1167	-1.58	0.19	1104	-0.02	0.26	0.26	0.37	-0.01
Base	-0.17	7.9	0.13	698	-0.32	7.6	0.1	645	-1.41	0.13	1167	-1.6	0.19	1104	0.15	0.3	0.23	0.32	-0.03
Left 150	-0.26	7.76	0.03	765	-0.57	7.5	0.01	680	-1.5	0.28	1242	-1.82	0.18	1125	0.31	0.26	0.04	0.46	0.05
Left 150	0.8	8.35	0.03	765	-1.61	8.37	0	680	-0.96	0.35	1242	-2.28	0.12	1125	2.41	-0.02	0.03	0.46	0.12
Left 150	-0.27	7.8	0.01	765	-0.56	7.46	0.02	680	-1.55	0.29	1242	-1.83	0.18	1125	0.29	0.34	0.04	0.47	0.06
Left 150	-0.27	7.79	0.02	765	-0.57	7.53	0.02	680	-1.53	0.29	1242	-1.81	0.18	1125	0.3	0.26	0.04	0.47	0.05
Left 150	-0.27	7.79	0.02	765	-0.57	7.46	0.01	680	-1.54	0.29	1242	-1.82	0.19	1125	0.3	0.33	0.04	0.48	0.05
Left 150	-0.27	7.77	0.03	765	-0.56	7.48	0.01	680	-1.53	0.29	1242	-1.82	0.19	1125	0.29	0.29	0.04	0.47	0.05
Left 150	-0.27	7.78	0.03	765	-0.56	7.44	0.01	680	-1.54	0.29	1242	-1.82	0.19	1125	0.29	0.33	0.04	0.48	0.05
Left 150	-0.33	7.78	0.02	765	-0.5	7.48	0.01	680	-1.56	0.28	1242	-1.83	0.19	1125	0.17	0.3	0.03	0.47	0.05
Left 150	-0.27	7.81	0.01	765	-0.56	7.5	0.02	680	-1.52	0.28	1242	-1.81	0.18	1125	0.3	0.31	0.03	0.46	0.05
Left 150	-0.27	7.81	0.01	765	-0.56	7.49	0.02	680	-1.54	0.28	1242	-1.81	0.19	1125	0.29	0.32	0.03	0.47	0.05
Left 150	0.19	8.34	0.02	760	-0.97	7.93	0.01	688	-1.02	0.23	1254	-2.12	0.12	1116	1.16	0.41	0.04	0.34	0.06
Left 150	-0.23	7.79	0.02	760	-0.57	7.47	0.01	688	-1.53	0.25	1254	-1.79	0.13	1116	0.34	0.32	0.02	0.38	0.06
Left 150	-0.23	7.82	0.02	760	-0.57	7.46	0.01	688	-1.54	0.25	1254	-1.81	0.13	1116	0.34	0.37	0.02	0.38	0.06
Left 150	-0.23	7.81	0.01	760	-0.57	7.48	0.03	688	-1.54	0.25	1254	-1.8	0.14	1116	0.34	0.33	0.03	0.39	0.06
Left 150	-0.23	7.83	0.01	760	-0.57	7.53	0.01	688	-1.56	0.25	1254	-1.82	0.14	1116	0.34	0.31	0.03	0.39	0.06
Left 150	-0.24	7.86	0	760	-0.56	7.47	0.02	688	-1.57	0.25	1254	-1.83	0.14	1116	0.33	0.4	0.02	0.39	0.06
Left 150	-0.23	7.88	0.01	760	-0.57	7.47	0.02	688	-1.55	0.25	1254	-1.81	0.14	1116	0.34	0.41	0.03	0.39	0.06
Left 150	-0.22	7.88	0	760	-0.58	7.47	0.02	688	-1.52	0.25	1254	-1.8	0.14	1116	0.36	0.41	0.02	0.39	0.05
Left 150	-0.223	7.8	0.01	760	-0.57	7.46	0.01	688	-1.54	0.25	1254	-1.8	0.13	1116	0.34	0.34	0.02	0.38	0.06
Left 150	-0.23	7.87	0.01	760	-0.57	7.43	0.02	688	-1.55	0.26	1254	-1.81	0.14	1116	0.35	0.43	0.03	0.4	0.06
Left 150	-0.38	7.93	0	764	-0.43	7.55	0.02	686	-1.59	0.23	1236	-1.7	0.16	1127	0.05	0.38	0.02	0.39	0.03
Left 150	-0.37	7.91	0.01	764	-0.42	7.56	0.01	686	-1.6	0.23	1236	-1.71	0.16	1127	0.05	0.34	0.03	0.39	0.03
Left 150	-0.27	7.81	0.02	764	-0.54	7.52	0.01	686	-1.56	0.23	1236	-1.78	0.16	1127	0.27	0.29	0.02	0.39	0.04
Left 150	-0.28	7.81	0.01	764	-0.54	7.51	0.01	686	-1.57	0.24	1236	-1.78	0.16	1127	0.26	0.3	0.02	0.39	0.04
Left 150	-0.3	7.76	0.01	764	-0.5	7.56	0.01	686	-1.53	0.23	1236	-1.74	0.15	1127	0.2	0.21	0.02	0.38	0.04
Left 150	-0.27	7.92	0.01	764	-0.54	7.52	0.01	686	-1.56	0.23	1236	-1.78	0.15	1127	0.27	0.39	0.02	0.38	0.04
Left 150	0.07	7.51	0	764	-0.89	7.32	0.01	686	-1.38	0.26	1236	-1.95	0.13	1127	0.96	0.19	0.01	0.38	0.07
Left 150	-0.4	7.75	0.01	764	-0.41	7.45	0.01	686	-1.7	0.23	1236	-1.59	0.15	1127	0.01	0.3	0.02	0.38	0.04
Left 150	-0.27	7.81	0.01	764	-0.54	7.45	0.01	686	-1.55	0.22	1236	-1.77	0.15	1127	0.28	0.36	0.02	0.37	0.04
Left 150	0.03	7.59	0.01	764	-0.83	7.33	0.02	686	-1.36	0.24	1236	-1.94	0.13	1127	86	0.26	0.02	0.36	0.05

Left 300	-0.27	7.98	-0.04	821	-0.75	7.75	-0.05	715	-1.7	0.37	1311	-2.1	0.23	1158	0.48	0.24	-0.09	0.59	0.07
Left 300	-0.45	7.82	-0.04	821	-0.58	7.69	-0.05	715	-1.93	0.35	1311	-1.87	0.22	1158	0.14	0.12	-0.1	0.57	0.06
Left 300	-0.43	7.88	-0.05	821	-0.6	7.71	-0.04	715	-1.89	0.35	1311	-1.87	0.23	1158	0.18	0.16	-0.09	0.57	0.06
Left 300	-0.42	7.83	-0.04	821	-0.62	7.67	-0.05	715	-1.89	0.35	1311	-1.92	0.23	1158	0.2	0.16	-0.09	0.58	0.06
Left 300	-0.27	7.92	-0.06	821	-0.76	7.78	-0.04	715	-1.74	0.36	1311	-2.11	0.23	1158	0.49	0.14	-0.1	0.59	0.06
Left 300	-0.28	7.98	-0.05	821	-0.76	7.73	-0.05	715	-1.74	0.35	1311	-2.11	0.23	1158	0.49	0.24	-0.1	0.57	0.06
Left 300	-0.45	7.92	-0.04	821	-0.59	7.65	-0.06	715	-1.94	0.34	1311	-1.89	0.22	1158	0.14	0.27	-0.1	0.56	0.06
Left 300	-0.42	7.82	-0.04	821	-0.62	7.64	-0.06	715	-1.91	0.35	1311	-1.92	0.23	1158	0.2	0.19	-0.1	0.58	0.06
Left 300	-0.42	7.88	-0.06	821	-0.61	7.66	-0.04	715	-1.92	0.34	1311	-1.92	0.22	1158	0.19	0.22	-0.1	0.56	0.06
Left 300	-0.28	7.99	-0.04	821	-0.75	7.79	-0.06	715	-1.74	0.35	1311	-2.1	0.22	1158	0.47	0.2	-0.1	0.57	0.07
Left 300	-0.44	7.98	-0.03	804	-0.57	7.65	-0.06	721	-1.95	0.33	1324	-1.87	0.23	1158	0.13	0.33	-0.09	0.56	0.05
Left 300	-0.41	8.02	-0.05	804	-0.61	7.55	-0.04	721	-1.93	0.34	1324	-1.91	0.23	1158	0.2	0.48	-0.09	0.57	0.06
Left 300	-0.4	7.86	-0.03	804	-0.61	7.6	-0.05	721	-1.92	0.33	1324	-1.91	0.23	1158	0.21	0.26	-0.09	0.56	0.05
Left 300	-0.45	7.89	-0.04	804	-0.7	7.51	-0.05	721	-1.96	0.33	1324	-1.92	0.24	1158	0.25	0.38	-0.08	0.57	0.05
Left 300	-0.27	7.92	-0.07	804	-0.75	7.69	-0.01	721	-1.74	0.33	1324	-2.1	0.23	1158	0.48	23	-0.08	0.57	0.05
Left 300	-0.26	7.95	-0.05	804	-0.75	7.66	-0.03	721	-1.74	0.34	1324	-2.1	0.24	1158	0.48	0.29	-0.08	0.58	0.05
Left 300	-0.4	7.85	-0.05	804	-0.6	7.61	-0.04	721	-1.93	0.33	1324	-1.94	0.23	1158	0.2	0.24	-0.09	0.55	0.05
Left 300	-0.27	7.98	-0.05	804	-0.74	7.65	-0.03	721	-1.76	0.34	1324	-2.11	0.24	1158	0.48	0.33	-0.09	0.58	0.05
Left 300	-0.27	8	-0.04	804	-0.74	7.7	-0.04	721	-1.75	0.35	1324	-2.1	0.24	1158	0.48	0.3	-0.07	0.59	0.05
Left 300	-0.27	7.98	-0.04	804	-0.74	7.76	-0.03	721	-1.75	0.34	1324	-2.1	0.24	1158	0.48	0.21	-0.07	0.59	0.05
Left 300	-0.25	7.94	-0.06	815	-0.75	7.66	-0.02	713	-1.73	0.36	1317	-2.1	0.25	1161	0.49	0.27	-0.08	0.61	0.05
Left 300	-0.25	7.98	-0.04	815	-0.75	7.72	-0.04	713	-1.74	0.35	1317	-2.11	0.23	1161	0.5	0.26	-0.08	0.57	0.06
Left 300	-0.24	7.99	-0.03	815	-0.83	7.64	-0.05	713	-1.74	0.34	1317	-2.11	0.23	1161	0.59	0.35	-0.08	0.57	0.06
Left 300	-0.25	8.04	-0.03	815	-0.74	7.65	-0.05	713	-1.74	0.35	1317	-2.11	0.23	1161	0.5	0.39	-0.08	0.58	0.06
Left 300	-0.25	7.99	-0.04	815	-0.75	7.66	-0.04	713	-1.74	0.35	1317	-2.1	0.24	1161	0.5	0.34	-0.08	0.58	0.06
Left 300	-0.25	7.94	-0.04	815	-0.75	7.66	-0.04	713	-1.74	0.35	1317	-2.09	0.24	1161	0.5	0.29	-0.08	0.59	0.06
Left 300	-0.25	8.09	-0.03	815	-0.75	7.65	-0.05	713	-1.73	0.35	1317	-2.11	0.24	1161	0.5	0.44	-0.08	0.58	0.06
Left 300	-0.24	7.97	-0.03	815	-0.75	7.66	-0.05	713	-1.73	0.35	1317	-2.11	0.24	1161	0.51	0.31	-0.08	0.59	0.06
Left 300	-0.35	8.07	-0.04	815	-0.59	7.65	-0.04	713	-1.77	0.35	1317	-2.15	0.24	1161	0.24	0.43	-0.08	0.59	0.05
Left 300	-0.26	7.95	-0.04	815	-0.74	7.62	-0.04	713	-1.74	0.34	1317	-2.11	0.23	1161	0.48	0.33	-0.08	0.57	0.05
Left 450	-0.11	8.21	-0.02	821	-0.83	7.77	-0.02	667	-2.02	0.23	1408	-2.39	0.29	1198	0.71	0.44	-0.04	0.52	-0.03
Left 450	-0.1	8.19	-0.03	821	-0.84	7.78	-0.01	667	-2.04	0.22	1408	-2.41	0.28	1198	0.74	0.41	-0.04	0.5	-0.03
Left 450	-0.1	8.15	-0.03	821	-0.84	7.77	-0.02	667	-2.03	0.21	1408	-2.4	0.28	1198	0.74	0.38	-0.05	0.49	-0.04
Left 450	-0.21	8.3	-0.03	821	-0.74	7.87	-0.03	667	-2.07	0.2	1408	-2.34	0.29	1198	0.54	0.43	-0.05	0.49	-0.05
Left 450	-0.14	8.21	-0.03	821	-0.81	7.84	-0.01	667	-2.08	0.68	1408	-2.4	0.19	1198	0.67	0.37	-0.05	0.87	0.25
Left 450	-0.14	8.07	-0.03	821	-0.82	7.84	-0.03	667	-2.08	0.69	1408	-2.4	0.2	1198	0.68	0.23	-0.05	0.89	0.25
Left 450	-0.14	8.07	0.01	821	0.82	7.83	-0.06	667	-2.1	0.69	1408	-2.41	0.21	1198	0.68	0.23	-0.05	0.89	0.24
Left 450	-0.14	8.14	-0.03	821	-0.82	7.84	-0.03	667	-2.1	0.69	1408	-2.41	0.21	1198	0.68	0.3	-0.05	0.9	0.24
Left 450	-0.14	8.11	-0.02	821	-0.82	7.78	-0.03	667	-2.1	0.7	1408	-2.41	0.22	1198	0.69	0.33	-0.05	0.91	0.24
Left 450	-0.14	8.18	-0.02	821	-0.83	7.75	-0.03	667	-2.09	0.69	1408	-2.41	0.21	1198	0.69	0.43	-0.05	0.9	0.24
Left 450	-0.14	8.15	-0.03	818	-0.82	7.75	-0.01	674	-2.17	0.64	1408	-2.38	0.23	1196	0.69	0.39	-0.04	0.87	0.21
Left 450	-0.13	8.07	-0.03	818	-0.83	7.75	-0.02	674	-2.15	0.63	1408	-2.39	0.22	1196	0.71	0.32	-0.05	0.85	0.21
Left 450	-0.13	8.03	-0.03	818	-0.83	7.78	-0.02	674	-2.17	0.63	1408	-2.4	0.22	1196	0.7	0.25	-0.05	0.85	0.2
Left 450	-0.13	8.06	-0.03	818	-0.84	7.75	-0.02	674	-2.17	0.61	1408	-2.4	0.22	1196	0.71	0.31	-0.05	0.83	0.2
Left 450	-0.14	8.03	-0.03	818	-0.83	7.76	-0.02	674	-2.16	0.61	1408	-2.39	0.23	1196	0.69	0.27	-0.05	0.84	0.19
Left 450	-0.14	8.03	-0.01	818	-0.83	7.76	-0.04	674	-2.16	0.62	1408	-2.39	0.23	1196	0.69	0.27	-0.05	0.85	0.19
Left 450	-0.14	8.07	-0.01	818	-0.83	7.79	-0.02	674	-2.16	0.61	1408	-2.39	0.22	1196	0.69	0.28	-0.03	84	0.19
Left 450	-0.14	8.03	-0.04	818	-0.83	7.77	-0.02	674	-2.17	0.61	1408	-2.39	0.22	1196	0.7	0.27	-0.05	0.83	0.19
Left 450	-0.13	8.14	-0.02	818	-0.83	7.77	-0.03	674	-2.17	0.61	1408	-2.39	0.22	1196	0.7	0.37	-0.05	0.83	0.2
Left 450	-0.14	8.06	0.01	818	-0.83	7.78	-0.06	674	-2.17	0.62	1408	-2.39	0.22	1196	0.7	0.28	-0.05	0.84	0.2
Left 450	-0.13	8.03	-0.02	816	-0.82	7.89	-0.01	675	-2.18	0.58	1407	-2.36	0.23	1197	0.69	0.14	-0.03	0.81	0.18
Left 450	-0.14	8.03	-0.03	816	-0.83	7.89	0	675	-2.22	0.58	1407	-2.39	0.23	1197	0.69	0.15	-0.04	0.81	0.18
Left 450	-0.14	8.04	-0.03	816	-0.82	7.73	-0.01	675	-2.2	0.57	1407	-2.37	0.22	1197	0.68	0.32	-0.03	0.79	0.18
Left 450	-0.14	8.08	-0.02	816	-0.83	7.79	-0.02	675	-2.19	0.58	1407	-2.36	0.22	1197	0.69	0.29	-0.04	0.79	0.18
Left 450	-0.14	8.04	-0.02	816	-0.81	7.79	-0.02	675	-2.2	0.57	1407	-2.38	0.22	1197	0.67	0.25	-0.04	0.79	0.18
Left 450	-0.14	8.13	-0.02	816	-0.82	7.73	-0.03	675	-2.19	0.57	1407	-2.37	0.22	1197	0.68	0.4	-0.04	0.79	0.17
Left 450	-0.14	8.12	-0.02	816	-0.81	7.77	-0.03	675	-2.21	0.57	1407	-2.39	0.22	1197	0.67	0.35	-0.04	0.79	0.18
Left 450	-0.1	8.14	-0.02	816	-0.81	7.8	-0.02	675	-2.21	0.58	1407	-2.4	0.22	1197	0.67	0.34	-0.04	0.8	0.18
Left 450	-0.13	8.18	-0.01	816	-0.8	7.72	-0.03	675	-1.81	0.31	1407	-2.35	0.16	1197	0.67	0.46	-0.05	0.47	0.07
Left 450	-0.13	8.16	-0.01	816	-0.81	7.74	-0.02	675	-7.89	0.33	1407	-2.42	0.21	1197	0.68	0.42	-0.03	0.54	0.06
Left 600	-0.06	8.18	-0.1	716	-1.09	7.73	-0.08	728	-1.89	0.41	1173	-2.71	0.21	1151	1.03	0.45	-0.18	0.62	0.1
Left 600	-0.07	8.15	-0.09	716	-1.09	7.8	-0.08	728	-1.89	0.4	1173	-2.71	0.21	1151	1.03	0.34	-0.17	0.61	0.1
Left 600	-0.07	8.15	-0.1	716	-1.09	7.78	-0.08	728	-1.91	0.42	1173	-2.73	0.23	1151	1.01	0.37	-0.17	0.65	0.1
Left 600	-0.07	8.17	-0.08	716	-1.09	7.71	-0.09	728	-1.89	0.41	1173	-2.73	0.22	1151	1.02	0.46	-0.18	0.63	0.1
Left 600	-0.06	8.16	-0.08	716	-1.1	7.78	-0.1	728	-1.88	0.4	1173	-2.71	0.22	1151	1.03	0.38	-0.17	0.62	0.09
Left 600	-0.06	8.16	-0.1	716	-1.1	7.74	-0.08	728	-1.89	0.42	1173	-2.73	0.23	1151	1.04	0.42	-0.17	0.64	0.1
Left 600	-0.05	8.16	-0.09	716	-1.1	7.71	-0.09	728	-1.88	0.41	1173	-2.72	0.22	1151	1.05	0.45	-0.18	0.62	0.1
Left 600	-0.06	8.15	-0.09	716	-1.11	7.65	-0.09	728	-1.87	0.41	1173	-2.71	0.22	1151	1.05	0.5	-0.17	0.63	0.1
Left 600	-0.05	8.16	-0.08	716	-1.11	7.83	-0.09	728	-1.87	0.41	1173	-2.71	0.23	1151	1.06	0.33	-0.17	0.65	0.09
Left 600	-0.05	8.11	-0.09	716	-1.11	7.82	-0.08	728	-1.87	0.42	1173	-2.71	0.24	1151	1.07	0.3	-0.17	0.65	0.09
Left 600	-0.11	8.21	-0.12	725	-1.06	7.73	-0.07	708	-1.94	0.35	1187	-2.6	0.26	1159	0.95	0.48	-0.19	0.61	0.04

Right 150	-0.43	7.89	0.05	716	-0.31	7.61	0.04	728	-1.84	0.07	1173	-1.6	0.14	1151	-0.12	0.28	0.09	0.21	-0.03
Right 150	-0.43	7.82	0.05	716	-0.31	7.63	0.04	728	-1.83	0.07	1173	-1.6	0.14	1151	-0.12	0.2	0.09	0.21	-0.03
Right 150	-0.42	7.82	0.04	716	-0.33	7.56	0.04	728	-1.83	0.06	1173	-1.63	0.14	1151	-0.1	0.26	0.09	0.2	-0.04
Right 150	-0.43	7.86	0.05	716	-0.32	7.55	0.04	728	-1.84	0.05	1173	-1.62	0.14	1151	-0.11	0.31	0.09	0.19	-0.05
Right 150	-0.42	7.86	0.06	716	-0.33	7.53	0.03	728	-1.83	0.06	1173	-1.62	0.15	1151	-0.1	0.33	0.09	0.21	-0.04
Right 150	-0.42	7.85	0.05	716	-0.32	7.56	0.05	728	-1.84	0.06	1173	-1.62	0.14	1151	-0.1	0.29	0.09	0.2	-0.04
Right 150	-0.43	7.89	0.07	716	-0.3	7.5	0.03	728	-1.81	0.04	1173	-1.62	0.15	1151	-0.13	0.39	0.1	0.18	-0.05
Right 150	-0.42	7.86	0.05	716	-0.33	7.57	0.04	728	-1.79	0.03	1173	-1.62	0.16	1151	-0.09	0.28	0.08	0.19	-0.07
Right 150	-0.42	7.86	0.05	716	-0.33	7.61	0.03	728	-1.8	0.03	1173	-1.62	0.14	1151	-0.09	0.25	0.08	0.17	-0.06
Right 150	-0.42	7.88	0.04	716	-0.33	7.57	0.05	728	-1.83	0.05	1173	-1.64	0.16	1151	-0.1	0.31	0.08	0.2	-0.06
Right 150	-0.39	7.75	0.1	725	-0.33	7.64	0.09	708	-1.68	0.3	1187	-1.65	0.18	1159	-0.06	0.11	0.19	0.48	0.07
Right 150	-0.28	7.81	0.1	725	-0.28	7.65	0.09	708	-1.68	0.3	1187	-1.74	0.18	1159	0	0.15	0.19	0.48	0.06
Right 150	-0.48	7.82	0.17	725	-0.32	7.64	0.03	708	-1.68	0.3	1187	-1.65	0.18	1159	-0.16	0.18	0.2	0.48	0.06
Right 150	-0.38	7.9	0.1	725	-0.33	7.69	0.09	708	-1.67	0.3	1187	-1.65	0.15	1159	-0.06	0.21	0.19	0.45	0.07
Right 150	-0.39	7.78	0.09	725	-0.32	7.76	0.1	708	-1.71	0.32	1187	-1.66	0.16	1159	-0.08	0.02	0.19	0.48	0.08
Right 150	-0.34	7.77	0.09	725	-0.31	7.67	0.1	708	-1.65	0.28	1187	-1.62	0.14	1159	-0.03	0.11	0.19	0.41	0.07
Right 150	-0.35	7.78	0.1	725	-0.29	7.64	0.09	708	-1.69	0.28	1187	-1.66	0.16	1159	-0.06	0.14	0.19	0.44	0.06
Right 150	-0.35	7.86	0.1	725	-0.29	7.62	0.09	708	-1.69	0.28	1187	-1.66	0.17	1159	-0.06	0.23	0.19	0.44	0.06
Right 150	-0.35	7.79	0.1	725	-0.3	7.59	0.09	708	-1.69	0.28	1187	-1.66	0.17	1159	-0.05	0.2	0.19	0.45	0.05
Right 150	-0.35	7.86	0.09	725	-0.3	7.63	0.09	708	-1.68	0.27	1187	-1.65	0.17	1159	-0.05	0.22	0.19	0.43	0.05
Right 150	-0.34	7.8	0.1	711	-0.29	7.63	0.1	715	-1.71	0.31	1199	-1.65	0.16	1155	-0.06	0.18	0.2	0.46	0.07
Right 150	-0.35	7.81	0.1	711	-0.29	7.57	0.09	715	-1.71	0.29	1199	-1.66	0.18	1155	-0.06	0.24	0.19	0.48	0.06
Right 150	-0.35	7.77	0.1	711	-0.29	7.64	0.09	715	-1.69	0.3	1199	-1.64	0.17	1155	-0.06	0.13	0.2	0.47	0.07
Right 150	-0.35	7.82	0.1	711	-0.29	7.72	0.1	715	-1.69	0.3	1199	-1.65	0.18	1155	-0.06	0.1	0.2	0.47	0.06
Right 150	-0.34	7.82	0.1	711	-0.3	7.69	0.1	715	-1.7	0.3	1199	-1.66	0.2	1155	-0.05	0.13	0.21	0.5	0.05
Right 150	-0.35	7.78	0.07	711	-0.29	7.71	0.12	715	-1.7	0.3	1199	-1.65	0.17	1155	-0.06	0.08	0.2	0.47	0.06
Right 150	-0.35	7.82	0.11	711	-0.29	7.73	0.09	715	-1.71	0.29	1199	-1.64	0.19	1155	-0.07	0.09	0.2	0.48	0.05
Right 150	-0.35	7.87	0.1	711	-0.29	7.73	0.09	715	-1.71	0.29	1199	-1.64	0.17	1155	-0.07	0.14	0.2	0.47	0.06
Right 150	-0.35	7.71	0.1	711	-0.29	7.61	0.1	715	-1.69	0.3	1199	-1.63	0.19	1155	-0.06	0.1	0.19	0.49	0.05
Right 150	-0.35	7.92	0.1	711	-0.29	7.68	0.1	715	-1.71	0.3	1199	-1.65	0.18	1155	-0.07	0.24	0.2	0.48	0.06
Right 300	-0.64	7.85	-0.02	733	-0.34	7.83	-0.02	776	-1.99	0.32	1217	-1.77	0.23	1227	-0.3	0.03	-0.03	0.55	0.05
Right 300	-0.63	7.85	-0.01	733	-0.34	7.8	-0.02	776	-1.97	0.32	1217	-1.75	0.23	1227	-0.29	0.05	-0.03	0.55	0.04
Right 300	-0.58	7.87	-0.01	733	-0.26	7.82	-0.02	776	-1.98	0.31	1217	-1.78	0.24	1227	-0.32	0.05	-0.04	0.55	0.04
Right 300	-0.63	7.91	-0.04	733	-0.35	7.76	0	776	-1.96	0.31	1217	-1.77	0.24	1227	-0.29	0.15	-0.04	0.55	0.04
Right 300	-0.63	7.9	-0.02	733	-0.35	7.78	-0.02	776	-1.95	0.31	1217	-1.77	0.24	1227	-0.28	0.12	-0.04	0.55	0.03
Right 300	-0.77	7.85	-0.01	733	-0.31	7.78	-0.03	776	-2.07	0.03	1217	-1.68	0.24	1227	-0.46	0.07	-0.04	0.54	0.03
Right 300	-0.63	7.87	-0.02	733	-0.34	7.8	-0.02	776	-1.96	0.3	1217	-1.77	0.24	1227	-0.29	0.08	-0.04	0.54	0.03
Right 300	-0.71	7.81	-0.04	733	-0.41	7.79	0	776	-1.91	0.31	1217	-1.89	0.25	1227	-0.3	0.02	-0.04	0.56	0.03
Right 300	-0.64	7.84	-0.03	733	-0.34	7.8	-0.02	776	-2	0.3	1217	-1.8	0.25	1227	-0.3	0.05	-0.05	0.55	0.03
Right 300	-0.63	7.87	-0.02	733	-0.34	7.8	-0.02	776	-1.98	0.3	1217	-1.79	0.25	1227	-0.3	0.07	-0.04	0.54	0.03
Right 300	-0.63	7.95	-0.04	746	-0.38	7.81	-0.03	779	-1.94	0.27	1203	-1.79	0.23	1206	-0.25	0.14	-0.06	0.5	0.02
Right 300	-0.63	7.82	-0.04	746	-0.38	7.76	-0.02	779	-1.95	0.28	1203	-1.78	0.24	1206	-0.25	0.06	-0.05	0.52	0.02
Right 300	-0.62	7.86	-0.03	746	-0.38	7.75	-0.03	779	-1.95	0.27	1203	-1.77	0.22	1206	-0.24	0.11	-0.06	0.49	0.02
Right 300	-0.62	7.74	-0.02	746	-0.37	7.77	-0.03	779	-1.95	0.27	1203	-1.77	0.21	1206	-0.25	-0.04	-0.05	0.48	0.03
Right 300	-0.63	7.81	-0.03	746	-0.37	7.7	-0.02	779	-1.95	0.28	1203	-1.77	0.23	1206	-0.25	0.11	-0.06	0.5	0.03
Right 300	-0.63	7.75	-0.03	746	-0.37	7.72	-0.01	779	-1.95	0.26	1203	-1.78	0.23	1206	-0.26	0.03	-0.04	0.49	0.02
Right 300	-0.63	7.73	-0.02	746	-0.36	7.7	-0.04	779	-1.97	0.28	1203	-1.79	0.23	1206	-0.27	0.03	-0.05	0.51	0.02
Right 300	-0.63	7.89	-0.05	746	-0.37	7.74	0.01	779	-1.96	0.27	1203	-1.79	0.23	1206	-0.26	0.15	-0.05	0.5	0.02
Right 300	-0.62	7.82	-0.05	746	-0.37	7.7	0	779	-1.96	0.26	1203	-1.79	0.22	1206	-0.25	0.12	-0.06	0.48	0.02
Right 300	-0.62	7.86	-0.03	746	-0.37	7.67	-0.02	779	-1.95	0.25	1203	-1.78	0.22	1206	-0.26	0.19	-0.05	0.47	0.02
Right 300	-0.64	7.88	0.01	729	-0.3	7.7	-0.01	769	-1.93	0.3	1207	-1.74	0.26	1231	-0.34	0.19	0	0.56	0.02
Right 300	-0.65	7.87	0	729	-0.28	7.61	0.01	769	-1.96	0.27	1207	-1.76	0.25	1231	-0.37	0.26	0.01	0.52	0.01
Right 300	-0.65	7.81	-0.01	729	-0.28	7.68	-0.01	769	-1.95	0.27	1207	-1.75	0.25	1231	-0.37	0.13	-0.01	0.52	0.01
Right 300	-0.64	7.92	0	729	-0.28	7.7	-0.01	769	-1.94	0.25	1207	-1.74	0.23	1231	-0.37	0.22	-0.01	0.48	0.01
Right 300	-0.64	7.85	0	729	-0.28	7.65	-0.02	769	-1.93	0.27	1207	-1.73	0.23	1231	-0.36	0.2	-0.01	0.5	0.02
Right 300	-0.64	7.74	-0.03	729	-0.28	7.68	0.01	769	-1.94	0.27	1207	-1.75	0.22	1231	-0.36	0.06	-0.02	0.49	0.03
Right 300	-0.62	7.9	-0.03	729	-0.37	7.72	-0.04	769	-1.93	0.26	1207	-1.76	0.19	1231	-0.25	0.19	-0.07	0.44	0.04
Right 300	-0.62	7.75	-0.04	729	-0.37	7.69	-0.03	769	-1.94	0.25	1207	-1.76	0.19	1231	-0.25	0.06	-0.07	0.44	0.03
Right 300	-0.63	7.83	-0.04	729	-0.36	7.76	-0.03	769	-1.97	0.25	1207	-1.78	0.19	1231	-0.27	0.07	-0.07	0.44	0.03
Right 300	-0.62	7.87	-0.04	729	-0.36	7.7	-0.03	769	-1.96	0.25	1207	-1.78	0.2	1231	-0.26	0.17	-0.07	0.45	0.03

Right 450	-0.77	7.93	-0.08	740	-0.32	7.73	-0.08	810	-2.18	0.26	1238	-1.93	0.25	1311	-0.45	0.2	-0.16	0.51	0.01
Right 450	-0.76	7.98	-0.07	740	-0.32	7.85	-0.08	810	-2.17	0.25	1238	-1.94	0.24	1311	-0.44	0.13	-0.16	0.49	0
Right 450	-0.76	7.96	-0.07	740	-0.32	7.76	-0.07	810	-2.16	0.25	1238	-1.93	0.26	1311	-0.43	0.2	-0.15	0.51	0
Right 450	-0.76	8.05	-0.08	740	-0.32	7.77	-0.08	810	-2.14	0.24	1238	-1.93	0.23	1311	-0.44	0.28	-0.16	0.47	0.01
Right 450	-0.77	8.02	-0.09	740	-0.32	7.72	-0.07	810	-2.16	0.25	1238	-1.94	0.25	1311	-0.45	0.3	-0.16	0.5	0
Right 450	-0.86	8.07	-0.08	740	-0.22	7.81	-0.09	810	-2.19	0.24	1238	-1.9	0.25	1311	-0.64	0.25	-0.17	0.49	0
Right 450	-0.77	8.02	-0.06	740	-0.31	7.69	-0.1	810	-2.15	0.26	1238	-1.96	0.23	1311	-0.46	0.33	-0.16	0.48	0.01
Right 450	-0.76	7.98	-0.07	740	-0.31	7.73	-0.09	810	-2.12	0.25	1238	-1.94	0.24	1311	-0.45	0.25	-0.17	0.49	0
Right 450	-0.76	7.89	-0.09	740	-0.31	7.72	-0.07	810	-2.11	0.26	1238	-1.93	0.23	1311	-0.45	0.17	-0.16	0.48	0.02
Right 450	-0.76	7.97	-0.1	740	-0.31	7.69	-0.07	810	-2.13	0.25	1238	-1.96	0.24	1311	-0.45	0.29	-0.17	0.5	0
Right 450	-0.75	7.93	-0.08	745	0.33	7.76	-0.06	790	-2.06	0.28	1230	-1.85	0.25	1348	-0.42	0.18	-0.14	0.54	0.02
Right 450	-0.75	7.93	-0.08	745	-0.32	7.87	-0.08	790	-2.05	0.28	1230	-1.84	0.26	1348	-0.43	0.06	-0.15	0.54	0.01
Right 450	-0.76	7.91	-0.08	745	-0.32	7.93	-0.07	790	-2.06	0.28	1230	-1.83	0.26	1348	-0.44	-0.02	-0.14	0.53	0.01
Right 450	-0.87	8.01	-0.07	745	-0.2	7.95	-0.08	790	-2.12	0.29	1230	-1.8	0.27	1348	-0.66	0.05	-0.15	0.56	0.01
Right 450	-0.77	7.99	-0.08	745	-0.31	7.86	-0.07	790	-2.07	0.29	1230	-1.84	0.26	1348	-0.46	0.13	-0.15	0.55	0.02
Right 450	-0.77	8.01	-0.09	745	-0.31	7.85	-0.06	790	-2.08	0.3	1230	-1.84	0.27	1348	-0.47	0.16	-0.15	0.57	0.02
Right 450	-0.54	7.8	-0.07	745	-0.56	7.72	-0.08	790	-1.93	0.32	1230	-1.93	0.23	1348	0.02	0.08	-0.15	0.55	0.05
Right 450	-0.77	8.05	-0.08	745	-0.31	7.81	-0.07	790	-2.1	0.29	1230	-1.84	0.26	1348	-0.47	0.24	-0.16	0.55	0.02
Right 450	-0.77	8	-0.1	745	-0.31	7.93	-0.05	790	-2.11	0.29	1230	-1.86	0.26	1348	-0.46	0.08	-0.15	0.56	0.02
Right 450	-0.78	8.02	-0.08	745	-0.31	7.8	-0.08	790	-2.09	0.29	1230	-1.84	0.26	1348	-0.47	0.22	-0.15	0.55	0.02
Right 450	-0.75	8.03	-0.06	732	-0.31	7.79	-0.05	818	-2.06	0.23	1245	-1.87	0.31	1313	-0.44	0.24	-0.11	0.54	-0.04
Right 450	-0.74	8.02	-0.06	732	-0.33	7.93	-0.08	818	-2.03	0.22	1245	-1.98	0.29	1313	-0.41	0.09	-0.14	0.51	-0.03
Right 450	-0.75	7.96	-0.07	732	-0.35	7.84	-0.08	818	-1.99	0.22	1245	-1.93	0.27	1313	-0.4	0.12	-0.15	0.48	-0.03
Right 450	-0.75	8.02	-0.07	732	-0.35	7.96	-0.08	818	-2.02	0.22	1245	-1.96	0.28	1313	-0.4	0.06	-0.16	0.5	-0.03
Right 450	-0.75	8	-0.07	732	-0.35	7.85	-0.07	818	-2.04	0.23	1245	-1.98	0.29	1313	-0.41	0.15	-0.15	0.52	-0.03
Right 450	-0.75	8.01	-0.08	732	-0.35	7.85	-0.07	818	-2.04	0.23	1245	-1.97	0.29	1313	-0.4	0.16	-0.15	0.52	-0.03
Right 450	-0.75	7.94	-0.08	732	-0.36	7.91	-0.07	818	-2.04	0.23	1245	-1.97	0.29	1313	-0.4	0.03	-0.14	0.52	-0.03
Right 450	-0.89	8	-0.08	732	-0.46	7.83	-0.07	818	-2.05	0.23	1245	-1.97	0.29	1313	-0.43	0.17	-0.15	0.52	-0.03
Right 450	-0.75	7.99	-0.06	732	-0.35	7.84	-0.08	818	-2.05	0.23	1245	-1.99	0.29	1313	-0.4	0.15	-0.14	0.53	-0.03
Right 450	-0.76	8.01	-0.06	732	-0.35	7.87	-0.07	818	-2.02	0.23	1245	-1.96	0.3	1313	-0.41	0.14	-0.13	0.53	-0.03
Right 600	-0.99	7.95	-0.19	767	-0.29	7.89	-0.17	882	-2.33	0.34	1260	-1.97	0.3	1358	-0.7	0.06	-0.35	0.64	0.02
Right 600	-0.99	7.97	-0.2	767	-0.29	7.83	-0.15	882	-2.37	0.32	1260	-1.97	0.28	1358	-0.71	0.14	-0.36	0.6	0.02
Right 600	-0.99	7.94	-0.18	767	-0.29	7.84	-0.18	882	-2.35	0.32	1260	-1.98	0.28	1358	-0.71	0.1	-0.36	0.6	0.02
Right 600	-1	7.95	-0.19	767	-0.29	7.86	-0.18	882	-2.38	0.33	1260	-2	0.3	1358	-0.71	0.09	-0.37	0.63	0.01
Right 600	-1	7.97	-0.21	767	-0.29	7.88	-0.15	882	-2.35	0.33	1260	-198	0.29	1358	-0.71	0.1	-0.36	0.62	0.02
Right 600	-0.99	7.87	-0.18	767	-0.29	7.83	-0.18	882	-2.35	0.33	1260	-1.97	0.31	1358	-0.7	0.04	-0.36	0.64	0.01
Right 600	-0.99	7.87	-0.2	767	-0.28	7.8	-0.17	882	-2.36	0.32	1260	-1.98	0.3	1358	-0.71	0.07	-0.36	0.62	0.01
Right 600	-0.99	7.97	-0.16	767	-0.29	7.88	-0.2	882	-2.36	0.33	1260	-1.99	0.3	1358	-0.69	0.09	-0.35	0.62	0.02
Right 600	-0.99	7.89	-0.17	767	-0.29	7.84	-0.19	882	-2.36	0.32	1260	-1.98	0.3	1358	-0.71	0.05	-0.36	0.62	0.01
Right 600	-0.99	7.85	-0.19	767	-0.29	7.81	-0.16	882	-2.37	0.32	1260	-2	0.31	1358	-0.69	0.03	-0.34	0.63	0.01
Right 600	-1	7.86	-0.17	771	-0.31	7.75	-0.16	881	-2.39	0.31	1255	-1.93	0.32	1359	-0.69	0.11	-0.33	0.63	-0.01
Right 600	-1.02	7.84	-0.16	771	-0.28	7.81	-0.18	881	-2.43	0.32	1255	-1.95	0.32	1359	-0.73	0.03	-0.34	0.64	0
Right 600	-1.01	7.86	-0.17	771	-0.29	7.77	-0.18	881	-2.41	0.32	1255	-1.94	0.29	1359	-0.73	0.1	-0.34	0.61	0.02
Right 600	-1.01	7.85	-0.17	771	-0.29	7.74	-0.18	881	-2.41	0.32	1255	-1.95	0.3	1359	-0.71	0.1	-0.34	0.62	0.01
Right 600	-1.01	7.89	-0.17	771	-0.28	7.77	-0.17	881	-2.41	0.32	1255	-1.96	0.28	1359	-0.73	0.13	-0.35	0.59	0.02
Right 600	-1.02	7.89	-0.18	771	-0.27	7.78	-0.17	881	-2.42	0.32	1255	-1.97	0.3	1359	-0.75	0.11	-0.35	0.63	0.01
Right 600	-1.01	7.87	-0.17	771	-0.28	7.82	-0.18	881	-2.43	0.31	1255	-1.97	0.32	1359	-0.73	0.05	-0.35	0.63	0
Right 600	-1.02	7.9	-0.23	771	-0.27	7.86	-0.12	881	-2.43	0.34	1255	-1.98	0.34	1359	-0.75	0.05	-0.35	0.68	0
Right 600	-1.01	7.92	-0.2	771	-0.27	7.8	-0.16	881	-2.41	0.31	1255	-1.98	0.31	1359	-0.74	0.12	-0.35	0.63	0
Right 600	-1.02	7.96	-0.19	771	-0.27	7.73	-0.17	881	-2.42	0.32	1255	-1.99	0.33	1359	-0.75	0.23	-0.36	0.66	-0.01
Right 600	-1	7.96	-0.17	769	-0.28	7.82	-0.18	881	-2.37	0.34	1268	-1.97	0.32	1350	-0.72	0.14	-0.35	0.66	0.01
Right 600	-1.01	7.92	-0.17	769	-0.29	7.74	-0.16	881	-2.43	0.32	1268	-1.96	0.32	1350	-0.72	0.18	-0.33	0.64	0
Right 600	-1	7.79	-0.15	769	-0.29	7.67	-0.2	881	-2.41	0.3	1268	-1.93	0.32	1350	-0.71	0.13	-0.35	0.62	-0.01
Right 600	-1	7.94	-0.17	769	-0.29	7.76	-0.17	881	-2.41	0.31	1268	-1.93	0.33	1350	-0.71	0.18	-0.34	0.64	-0.01
Right 600	-1.01	7.89	-0.17	769	-0.29	7.8	-0.18	881	-2.41	0.3	1268	-1.93	0.32	1350	-0.71	0.09	-0.34	0.63	-0.01
Right 600	-1.01	7.85	-0.17	769	-0.29	7.78	-0.17	881	-2.41	0.3	1268	-1.94	-1.87	1350	-0.71	0.08	-0.34	0.62	-0.01
Right 600	-1	7.83	-0.18	769	-0.3	7.76	-0.16	881	-2.39	0.31	1268	-1.92	0.32	1350	-0.71	0.07	-0.34	0.63	-0.01
Right 600	-1.02	7.82	-0.17	769	-0.28	7.82	-0.17	881	-2.43	0.3	1268	-1.92	0.32	1350	-0.74	-0.01	-0.34	0.61	-0.01
Right 600	-1.01	7.81	-0.18	769	-0.28	7.88	-0.17	881	-2.41	0.3	1268	-1.92	0.32	1350	-0.73	-0.07	-0.34	0.61	-0.01
Right 600	-0.98	7.9	-0.16	769	-0.31	7.78	-0.18	881	-2.38	0.3	1268	-1.96	0.32	1350	-0.68	0.12	-0.34	0.61	-0.01

Front 150	-0.46	7.47	-0.03	795	-0.66	7.28	-0.05	747	-1.39	0.22	1163	-1.54	0.16	1078	0.2	0.19	-0.08	0.38	0.03
Front 150	-0.46	7.51	-0.04	795	-0.65	7.27	-0.04	747	-1.39	0.21	1163	-1.54	0.14	1078	0.19	0.24	-0.08	0.35	0.04
Front 150	-0.46	7.56	-0.04	795	-0.65	7.37	-0.04	747	-1.4	0.22	1163	-1.56	0.14	1078	0.2	0.19	-0.08	0.36	0.04
Front 150	-0.46	7.55	-0.04	795	-0.65	7.28	-0.03	747	-1.42	0.22	1163	-1.56	0.14	1078	0.19	0.27	-0.07	0.36	0.04
Front 150	-0.46	7.54	-0.04	795	-0.65	7.25	-0.03	747	-1.4	0.22	1163	-1.54	0.14	1078	0.19	0.29	-0.07	0.36	0.04
Front 150	-0.57	7.61	-0.05	795	-0.53	7.46	-0.02	747	-1.47	0.22	1163	-1.47	0.14	1078	-0.04	0.15	-0.07	0.36	0.04
Front 150	-0.46	7.56	-0.03	795	-0.65	7.28	-0.05	747	-1.41	0.22	1163	-1.54	0.13	1078	0.19	0.28	-0.07	0.35	0.04
Front 150	-0.46	7.54	-0.03	795	-0.65	7.31	-0.04	747	-1.39	0.21	1163	-1.53	0.12	1078	0.19	0.22	-0.07	0.33	0.04
Front 150	-0.46	7.45	-0.03	795	-0.65	7.34	-0.04	747	-1.41	0.21	1163	-1.53	0.13	1078	0.19	0.11	-0.07	0.34	0.04
Front 150	-0.46	7.5	-0.04	795	-0.65	7.28	-0.03	747	-1.4	0.21	1163	-1.53	0.13	1078	0.18	0.21	-0.08	0.34	0.04
Front 150	-0.47	7.48	-0.04	798	-0.65	7.2	-0.04	747	-1.38	0.22	1163	-1.52	0.13	1077	0.18	0.27	-0.08	0.35	0.05
Front 150	-0.44	7.54	-0.04	798	-0.65	7.24	-0.04	747	-1.39	0.2	1163	-1.52	0.13	1077	0.21	0.31	-0.08	0.33	0.04
Front 150	-0.51	7.59	-0.03	798	-0.54	7.38	-0.05	747	-1.41	0.21	1163	-1.52	0.13	1077	0.03	0.2	-0.08	0.34	0.04
Front 150	-0.47	7.58	-0.05	798	-0.65	7.33	-0.03	747	-1.42	0.22	1163	-1.53	0.14	1077	0.18	0.25	-0.08	0.35	0.04
Front 150	-0.46	7.6	-0.03	798	-0.64	7.26	-0.05	747	-1.41	0.21	1163	-1.52	0.13	1077	0.18	0.34	-0.07	0.33	0.04
Front 150	-0.47	7.51	-0.04	798	-0.64	7.25	-0.07	747	-1.38	0.21	1163	-1.5	0.12	1077	0.17	0.26	-0.12	0.33	0.05
Front 150	-0.47	7.58	-0.07	798	-0.64	7.26	-0.06	747	-1.41	0.2	1163	-1.51	0.11	1077	0.17	0.32	-0.12	0.31	0.04
Front 150	-0.46	7.51	-0.05	798	-0.62	7.28	-0.04	747	-1.4	0.22	1163	-1.5	0.17	1077	0.16	0.23	-0.09	0.39	0.02
Front 150	-0.48	7.6	-0.04	798	-0.62	7.33	-0.06	747	-1.42	0.22	1163	-1.5	0.16	1077	0.14	0.27	-0.1	0.37	0.03
Front 150	-0.47	7.53	-0.04	798	-0.62	7.36	-0.05	747	-1.42	0.23	1163	-1.49	0.16	1077	0.15	0.17	-0.1	0.4	0.04
Front 150	-0.03	8.11	-0.05	800	-1.07	7.73	-0.07	741	-0.9	0.22	1160	-1.92	0.1	1079	1.04	0.38	-0.12	0.32	0.06
Front 150	-0.48	7.46	-0.05	800	-0.65	7.21	-0.07	741	-1.38	0.22	1160	-1.49	0.11	1079	0.17	0.25	-0.12	0.33	0.05
Front 150	0.51	8.17	-0.07	800	-1.6	7.95	-0.07	741	-0.92	0.27	1160	-1.99	0.05	1079	2.11	0.22	-0.14	0.32	0.11
Front 150	-0.47	7.62	-0.05	800	-0.66	7.3	-0.07	741	-1.4	0.22	1160	-1.51	0.11	1079	0.18	0.32	-0.13	0.32	0.06
Front 150	-0.47	7.56	-0.05	800	-0.63	7.19	-0.04	741	-1.3	0.2	1160	-1.39	0.14	1079	0.16	0.37	-0.09	0.35	0.03
Front 150	-0.48	7.58	-0.04	800	-0.64	7.32	-0.05	741	-1.38	0.22	1160	-1.47	0.17	1079	0.16	0.26	-0.09	0.39	0.03
Front 150	-0.48	7.47	-0.05	800	-0.64	7.35	-0.05	741	-1.4	0.22	1160	-1.5	0.17	1079	0.16	0.11	-0.1	0.39	0.03
Front 150	-0.48	7.57	-0.05	800	-0.64	7.28	-0.06	741	-1.4	0.22	1160	-1.5	0.17	1079	0.16	0.28	-0.11	0.39	0.02
Front 150	-0.48	7.5	-0.06	800	-0.64	7.32	-0.05	741	-1.39	0.21	1160	-1.48	0.18	1079	0.17	0.19	-0.11	0.39	0.02
Front 150	-0.48	7.46	-0.05	800	-0.64	7.29	-0.06	741	-1.37	0.21	1160	-1.47	0.17	1079	0.16	0.17	-0.11	0.38	0.02
Front 300	-0.71	7.29	-0.21	910	-0.87	7.1	-0.24	840	-1.33	0.22	1131	-1.43	0.17	1061	0.16	0.19	-0.45	0.39	0.02
Front 300	-0.71	7.23	-0.22	910	-0.87	6.97	-0.21	840	-1.33	0.22	1131	-1.42	0.19	1061	0.16	0.27	-0.43	0.41	0.02
Front 300	-0.71	7.3	-0.24	910	-0.87	7.08	-0.21	840	-1.33	0.21	1131	-1.42	0.18	1061	0.16	0.22	-0.45	0.4	0.02
Front 300	-0.71	7.29	-0.25	910	-0.87	7.13	-0.2	840	-1.32	0.21	1131	-1.41	0.18	1061	0.16	0.16	-0.45	0.39	0.01
Front 300	-0.71	7.39	-0.22	910	-0.87	7.14	-0.23	840	-1.33	0.2	1131	-1.4	0.18	1061	0.16	0.25	-0.45	0.38	0.01
Front 300	-0.71	7.3	-0.22	910	-0.86	7.02	-0.23	840	-1.33	0.21	1131	-1.42	0.17	1061	0.15	0.28	-0.45	0.37	0.02
Front 300	-0.82	7.44	-0.22	910	-0.74	7.18	-0.23	840	-1.39	0.2	1131	-1.35	0.17	1061	-0.08	0.26	-0.45	0.37	0.02
Front 300	-0.71	7.35	-0.22	910	-0.86	7.09	-0.23	840	-1.33	0.21	1131	-1.41	0.17	1061	0.15	0.25	-0.44	0.38	0.02
Front 300	-0.7	7.34	-0.21	910	-0.87	7.05	-0.25	840	-1.31	0.2	1131	-1.41	0.16	1061	0.17	0.29	-0.46	0.39	0.02
Front 300	-0.7	7.35	-0.24	910	-0.87	7.07	-0.22	840	-1.31	0.2	1131	-1.41	0.17	1061	0.18	0.28	-0.45	0.37	0.02
Front 300	-0.7	7.28	-0.22	913	-0.89	6.95	-0.23	842	-1.27	0.23	1137	-1.42	0.12	1060	0.19	0.33	-0.45	0.35	0.05
Front 300	-0.7	7.32	-0.21	913	-0.89	6.94	-0.25	842	-1.28	0.21	1137	-1.43	0.12	1060	0.2	0.38	-0.46	0.33	0.05
Front 300	-0.69	7.32	-0.22	913	-0.89	6.9	-0.24	842	-1.27	0.19	1137	-1.43	0.12	1060	0.2	0.42	-0.46	0.31	0.03
Front 300	-0.7	7.28	-0.23	913	-0.89	6.99	-0.24	842	-1.26	0.17	1137	-1.42	0.12	1060	0.2	0.29	-0.46	0.28	0.03
Front 300	-0.7	7.34	-0.23	913	-0.9	7.04	-0.23	842	-1.26	0.17	1137	-1.44	0.12	1060	0.2	0.31	-0.45	0.28	0.03
Front 300	-0.7	7.3	-0.24	913	-0.9	7.02	-0.22	842	-1.28	0.16	1137	-1.43	0.11	1060	0.2	0.28	-0.47	0.27	0.02
Front 300	-0.7	7.38	-0.24	913	-0.9	7.09	-0.22	842	-1.27	0.15	1137	-1.42	0.12	1060	0.2	0.29	-0.46	0.27	0.02
Front 300	-0.7	7.36	-0.22	913	0.89	7.06	-0.25	842	-1.28	0.15	1137	-1.42	0.12	1060	0.19	0.3	-0.47	0.27	0.02
Front 300	-0.82	7.54	-0.23	913	-0.77	7.07	-0.24	842	-1.35	0.15	1137	-1.35	0.13	1060	-0.05	0.47	-0.46	0.28	0.01
Front 300	-0.7	7.31	-0.23	913	-0.89	7.04	-0.24	842	-1.29	0.16	1137	-1.42	0.11	1060	0.19	0.27	-0.47	0.27	0.02
Front 300	-0.77	7.29	-0.24	908	-0.99	6.98	-0.23	839	-1.31	0.2	1149	-1.43	0.1	1051	0.21	0.31	-0.46	0.3	0.05
Front 300	-0.7	7.37	-0.23	908	-0.9	7.13	-0.24	839	-1.33	0.19	1149	-1.43	0.08	1051	0.2	0.25	-0.47	0.27	0.06
Front 300	-0.7	7.39	-0.2	908	-0.89	7.02	-0.27	839	-1.32	0.2	1149	-1.39	0.11	1051	0.19	0.37	-0.47	0.3	0.05
Front 300	-0.7	7.28	-0.23	908	-0.9	7.01	-0.23	839	-1.31	0.21	1149	-1.38	0.12	1051	0.2	0.27	-0.46	0.33	0.04
Front 300	-0.76	7.36	-0.23	908	-0.94	7.06	-0.23	839	-1.33	0.2	1149	-1.41	0.13	1051	0.18	0.3	-0.46	0.33	0.04
Front 300	-0.69	7.4	-0.25	908	-0.9	7.14	-0.22	839	-1.31	0.21	1149	-1.4	0.12	1051	0.2	0.25	-0.47	0.33	0.04
Front 300	-0.69	7.33	-0.22	908	-0.9	7.15	-0.25	839	-1.32	0.2	1149	-1.39	0.14	1051	0.21	0.18	-0.46	0.33	0.03
Front 300	-0.68	7.37	-0.21	908	-0.9	7.09	-0.23	839	-1.28	0.2	1149	-1.41	0.15	1051	0.22	0.28	-0.44	0.34	0.03
Front 300	-0.69	7.42	-0.23	908	-0.91	7	-0.25	839	-1.26	0.18	1149	-1.35	0.13	1051	0.22	0.42	-0.48	0.31	0.02
Front 300	-0.68	7.38	-0.24	908	-0.91	7.17	-0.23	839	-1.28	0.18	1149	-1.36	0.15	1051	0.23	0.2	-0.46	0.33	0.02

Front 400	-0.73	7.26	-0.34	979	-1	6.95	-0.34	892	-1.32	0.22	1135	-1.37	0.13	1049	0.27	0.31	-0.68	0.35	0.04
Front 400	-0.73	7.23	-0.34	979	-0.99	6.89	-0.34	892	-1.32	0.21	1135	-1.37	0.13	1049	0.26	0.34	-0.68	0.34	0.04
Front 400	-0.73	7.31	-0.33	979	-0.98	6.87	-0.36	892	-1.31	0.2	1135	-1.36	0.13	1049	0.25	0.44	-0.69	0.34	0.03
Front 400	-0.72	7.25	-0.36	979	-1	6.89	-0.34	892	-1.3	0.19	1135	-1.37	0.15	1049	0.28	0.36	-0.7	0.34	0.02
Front 400	-0.72	7.18	-0.35	979	-0.99	6.92	-0.35	892	-1.31	0.21	1135	-1.38	0.14	1049	0.26	0.27	-0.7	0.35	0.04
Front 400	-0.73	7.34	-0.36	979	-0.98	6.88	-0.34	892	-1.32	0.2	1135	-1.38	0.12	1049	0.26	0.46	-0.71	0.32	0.04
Front 400	-0.74	7.31	-0.36	979	-0.98	6.85	-0.35	892	-1.34	0.18	1135	-1.36	0.12	1049	0.24	0.47	-0.7	0.3	0.03
Front 400	-0.74	7.24	-0.36	979	-0.97	6.95	-0.35	892	-1.35	0.18	1135	-1.37	0.12	1049	0.23	0.28	-0.71	0.3	0.03
Front 400	-0.75	7.24	-0.35	979	-0.96	6.87	-0.36	892	-1.35	0.18	1135	-1.36	0.13	1049	0.21	0.37	-0.7	0.3	0.03
Front 400	-0.76	7.25	-0.34	979	-0.95	6.91	-0.36	892	-1.38	0.17	1135	-1.36	0.13	1049	0.2	0.34	-0.7	0.3	0.02
Front 400	-0.73	7.24	-0.34	958	-0.99	6.84	-0.35	913	-1.34	0.17	1123	-1.4	0.15	1059	0.26	0.41	-0.69	0.32	0.01
Front 400	-0.72	7.22	-0.35	958	-0.99	6.81	-0.34	913	-1.33	0.19	1123	-1.42	0.14	1059	0.27	0.41	-0.7	0.33	0.03
Front 400	-0.74	7.22	-0.36	958	-0.98	6.81	-0.34	913	-1.34	0.2	1123	-1.43	0.13	1059	0.25	0.41	-0.7	0.33	0.03
Front 400	-0.72	7.28	-0.35	958	-1	6.92	-0.34	913	-1.33	0.19	1123	-1.43	0.14	1059	0.28	0.36	-0.69	0.33	0.03
Front 400	-0.74	7.25	-0.34	958	-0.97	6.95	-0.35	913	-1.34	0.19	1123	-1.44	0.13	1059	0.23	0.3	-0.69	0.32	0.03
Front 400	-0.78	7.16	-0.34	958	-0.94	6.94	-0.34	913	-1.37	0.19	1123	-1.42	0.12	1059	0.17	0.22	-0.67	0.31	0.04
Front 400	-0.7	7.24	-0.36	958	-1.02	6.88	-0.35	913	-1.27	0.23	1123	-1.35	-0.01	1059	0.32	0.36	-0.71	0.22	0.12
Front 400	-0.71	7.23	-0.35	958	-1.03	6.95	-0.34	913	-1.3	0.22	1123	-1.34	0.01	1059	0.32	0.27	-0.7	0.23	0.11
Front 400	-0.71	7.26	-0.36	958	-1.02	6.94	-0.34	913	-1.3	0.22	1123	-1.33	0	1059	0.31	0.32	-0.7	0.22	0.11
Front 400	-0.72	7.27	-0.35	958	-1.02	6.95	-0.36	913	-1.3	0.22	1123	-1.33	0.01	1059	0.3	0.25	-0.7	0.23	0.11
Front 400	-0.82	7.31	-0.36	962	-1.03	7.05	-0.34	909	-1.26	0.21	1130	-1.4	0.17	1053	0.21	0.27	-0.7	0.37	0.02
Front 400	-0.82	7.19	-0.34	962	-1.03	7.03	-0.36	909	-1.26	0.2	1130	-1.41	0.16	1053	0.21	0.16	-0.7	0.36	0.02
Front 400	-0.82	7.25	0.37	962	-1.03	7.02	-0.34	909	-1.26	0.19	1130	-1.4	0.15	1053	0.21	0.23	-0.71	0.34	0.02
Front 400	-0.82	7.21	-0.36	962	-1.05	7.01	-0.34	909	-1.26	0.2	1130	-1.42	0.15	1053	0.23	0.2	-0.7	0.35	0.02
Front 400	-0.82	7.2	-0.34	962	-1.03	7.03	-0.37	909	-1.27	0.21	1130	-1.41	0.16	1053	0.21	0.17	-0.71	0.37	0.02
Front 400	-0.82	7.24	-0.35	962	-1.03	6.98	-0.35	909	-1.27	0.2	1130	-1.41	0.16	1053	0.21	0.27	-0.7	0.36	0.02
Front 400	-0.82	7.28	-0.34	962	-1.04	6.99	-0.37	909	-1.27	0.2	1130	-1.42	0.18	1053	0.22	0.29	-0.71	0.38	0.01
Front 400	-0.81	7.14	-0.36	962	-1.04	7.04	-0.35	909	-1.27	0.2	1130	-1.42	0.16	1053	0.23	0.09	-0.71	0.36	0.02
Front 400	-0.82	7.11	-0.35	962	-1.03	7.03	-0.35	909	-1.28	0.2	1130	-1.42	0.15	1053	0.22	0.08	-0.7	0.35	0.02
Front 400	-0.82	7.15	-0.35	962	-1.03	7.01	-0.36	909	-1.29	0.2	1130	-1.42	0.16	1053	0.21	0.14	-0.71	0.36	0.02
Front 500	-0.92	7.02	-0.49	1028	-1.14	6.9	-0.4	978	-1.25	0.2	1116	-1.36	0.16	1044	0.22	0.11	-0.89	0.35	0.02
Front 500	-0.9	7.13	-0.44	1028	-1.15	6.91	-0.46	978	-1.25	0.19	1116	-1.37	0.16	1044	0.23	0.21	-0.9	0.35	0.01
Front 500	-0.93	7.08	-0.45	1028	-1.06	6.93	-0.46	978	-1.28	0.17	1116	-1.4	0.16	1044	0.14	0.16	-0.91	0.33	0.01
Front 500	-0.92	7.03	-0.47	1028	-1.15	6.82	-0.43	978	-1.27	0.15	1116	-1.38	0.15	1044	0.22	0.21	-0.9	0.3	0
Front 500	-0.92	7.07	-0.44	1028	-1.16	6.85	-0.45	978	-1.26	0.14	1116	-1.38	0.16	1044	0.24	0.22	-0.89	0.3	-0.01
Front 500	-0.93	7.09	-0.44	1028	-1.13	6.88	-0.45	978	-1.26	0.17	1116	-1.39	0.16	1044	0.2	0.22	-0.89	0.33	0.01
Front 500	-0.95	6.93		1028	-1.13	6.98		978	-1.27		1116	-1.38		1044	0.18	-0.05			-0.01
Front 500	-0.9	7.16	-0.44	1028	-1.17	6.89	-0.45	978	-1.22	0.18	1116	-1.42	0.16	1044	0.27	0.27	-0.9	0.33	0.01
Front 500	-0.91	7.1		1028	-1.16	6.89		978	-1.25		1116	-1.43		1044	0.24	0.21			0.01
Front 500	-0.91	7.12	-0.45	1028	-1.15	6.88	-0.46	978	-1.18	0.18	1116	-1.38	0.11	1044	0.24	0.24	-0.91	0.29	0.03
Front 500	-0.95	7.02	-0.43	1026	-1.12	6.72	-0.44	988	-1.23	0.18	1110	-1.34	0.19	1038	0.18	0.3	-0.87	0.37	-0.01
Front 500	-0.94	7.07	-0.45	1026	-1.13	6.79	-0.42	988	-1.24	0.18	1110	-1.35	0.18	1038	0.19	0.28	-0.87	0.36	0
Front 500	-0.94	7.02	-0.44	1026	-1.14	6.74	-0.44	988	-1.24	0.14	1110	-1.34	0.16	1038	0.19	0.28	-0.88	0.3	-0.01
Front 500	-0.93	6.99	-0.44	1026	-1.14	6.77	-0.44	988	-1.24	0.14	1110	-1.36	0.18	1038	0.21	0.22	-0.87	0.32	-0.02
Front 500	-0.93	7.12	-0.46	1026	-1.13	6.75	-0.43	988	-1.24	0.16	1110	-1.36	0.18	1038	0.2	0.38	-0.89	0.34	-0.01
Front 500	-0.94	7.01		1026	-1.12	6.83		988	-1.25		1110	-1.37		1038	0.18	0.18			-0.01
Front 500	-0.95	7.03		1026	-1.11	6.77		988	-1.24		1110	-1.35		1038	0.16	0.26			-0.01
Front 500	-0.93	7.11	-0.44	1026	-1.12	6.74	-0.43	988	-1.22	0.21	1110	-1.35	0.18	1038	0.18	0.37	-0.87	0.39	0.02
Front 500	-0.93	7.05		1026	-1.12	6.75		988	-1.22		1110	-1.36		1038	0.19	0.3			0.02
Front 500	-0.94	7.01		1026	-1.11	6.76		988	-1.25		1110	-1.35		1038	0.17	0.25			0.01
Front 500	-0.92	7.06	-0.44	1031	-1.06	6.8	-0.45	996	-1.33	0.27	1079	-1.39	0.19	1050	0.14	0.26	-0.89	0.46	0.04
Front 500	-0.92	7.08	-0.45	1031	-1.07	6.78	-0.46	996	-1.34	0.27	1079	-1.42	0.17	1050	0.15	0.3	-0.9	0.44	0.05
Front 500	-0.93	7.09	-0.45	1031	-1.07	6.84	-0.46	996	-1.34	0.25	1079	-1.42	0.16	1050	0.14	0.25	-0.91	0.41	0.04
Front 500	-0.94	7.06	-0.47	1031	-1.06	6.83	-0.44	996	-1.37	0.24	1079	-1.41	0.16	1050	0.12	0.23	-0.9	0.41	0.04
Front 500	-0.93	7.12	-0.44	1031	-1.07	6.86	-0.43	996	-1.4	0.24	1079	-1.36	0.1	1050	0.14	0.26	-0.87	0.34	0.07
Front 500	-0.93	7.08	-0.43	1031	-1.07	6.85	-0.45	996	-1.4	0.24	1079	-1.36	0.1	1050	0.14	0.24	-0.88	0.34	0.07
Front 500	-0.96	7.13	-0.45	1031	-1.08	6.9	-0.44	996	-1.42	0.23	1079	-1.35	0.1	1050	0.12	0.23	-0.89	0.32	0.07
Front 500	-0.91	7.09	-0.42	1031	-1.03	6.83	-0.42	996	-1.42	0.29	1079	-1.34	0.22	1050	0.12	0.26	-0.84	0.51	0.04
Front 500	-0.88	7.14	-0.4	1031	-1.02	6.83	-0.41	996	-1.42	0.34	1079	-1.37	0.32	1050	0.15	0.31	-0.81	0.66	0.01
Front 500	-0.87	7.16	-0.39	1031	-1.02	6.91	-0.4	996	-1.41	0.36	1079	-1.35	0.35	1050	0.15	0.25	-0.79	0.71	0.01

Back 150	-0.35	7.93	0.06	728	-0.4	7.75	0.07	697	-1.71	0.29	1231	-1.77	0.24	1175	0.05	0.18	0.13	0.52	0.02
Back 150	-0.35	7.89	0.07	728	-0.41	7.58	0.06	697	-1.72	0.25	1231	-1.78	0.21	1175	0.05	0.3	0.12	0.47	0.02
Back 150	-0.35	7.94	0.05	728	-0.41	7.65	0.07	697	-1.72	0.26	1231	-1.78	0.22	1175	0.05	0.3	0.12	0.48	0.02
Back 150	-0.35	7.79	0.07	728	-0.41	7.63	0.05	697	-1.67	0.23	1231	-1.73	0.19	1175	0.06	0.16	0.12	0.43	0.02
Back 150	-0.35	7.86	0.07	728	-0.41	7.65	0.05	697	-1.73	0.25	1231	-1.78	0.22	1175	0.06	0.21	0.11	0.47	0.02
Back 150	-0.35	7.79	0.08	728	-0.41	7.61	0.03	697	-1.72	0.26	1231	-1.77	0.22	1175	0.06	0.18	0.11	0.47	0.02
Back 150	0.08	7.45	0.06	728	-0.86	7.34	0.05	697	-1.5	0.32	1231	-1.98	0.17	1175	0.95	0.11	0.11	0.49	0.08
Back 150	-0.35	7.84	0.06	728	-0.4	7.6	0.05	697	-1.72	0.26	1231	-1.77	0.22	1175	0.05	0.24	0.11	0.48	0.02
Back 150	-0.35	7.89	0.05	728	-0.41	7.59	0.06	697	-1.72	0.25	1231	-1.78	0.21	1175	0.06	0.3	0.11	0.46	0.02
Back 150	-0.34	7.87	0.06	728	-0.4	7.6	0.06	697	-1.73	0.26	1231	-1.77	0.22	1175	0.06	0.27	0.12	0.48	0.02
Back 150	-0.41	7.87	0.06	727	-0.31	7.62	0.06	698	-1.77	0.27	1233	-1.71	0.21	1160	-0.1	0.25	0.12	0.48	0.03
Back 150	-0.33	7.82	0.07	727	-0.4	7.56	0.06	698	-1.74	0.26	1233	-1.75	0.2	1160	0.07	0.26	0.13	0.46	0.03
Back 150	-0.32	7.83	0.05	727	-0.41	7.57	0.07	698	-1.74	0.26	1233	-1.75	0.2	1160	0.08	0.26	0.12	0.46	0.03
Back 150	-0.33	7.81	0.07	727	-0.4	7.55	0.05	698	-1.74	0.26	1233	-1.75	0.21	1160	0.07	0.27	0.13	0.47	0.02
Back 150	-0.32	7.83	0.07	727	-0.41	7.55	0.06	698	-1.76	0.26	1233	-1.77	0.21	1160	0.08	0.28	0.13	0.47	0.03
Back 150	-0.33	7.78	0.06	727	-0.4	7.6	0.07	698	-1.76	0.27	1233	-1.76	0.21	1160	0.07	0.18	0.13	0.48	0.03
Back 150	-0.33	7.85	0.07	727	-0.4	7.53	0.05	698	-1.75	0.26	1233	-1.76	0.21	1160	0.07	0.32	0.12	0.47	0.03
Back 150	-0.33	7.86	0.06	727	-0.4	7.62	0.06	698	-1.74	0.26	1233	-1.76	0.2	1160	0.07	0.24	0.12	0.46	0.03
Back 150	-0.33	7.8	0.06	727	-0.4	7.62	0.06	698	-1.74	0.25	1233	-1.75	0.2	1160	0.07	0.17	0.12	0.45	0.03
Back 150	-0.44	7.89	0.06	727	-0.28	7.67	0.07	698	-1.8	0.26	1233	-1.69	0.21	1160	-0.16	0.22	0.13	0.46	0.03
Back 150	-0.33	7.82	0.06	724	-0.37	7.68	0.07	697	-1.79	0.28	1231	-1.76	0.21	1174	0.04	0.13	0.13	0.49	0.04
Back 150	-0.33	7.88	0.06	724	-0.37	7.6	0.06	697	-1.76	0.25	1231	-1.73	0.21	1174	0.05	0.29	0.12	0.46	0.02
Back 150	-0.33	7.86	0.04	724	-0.37	7.6	0.09	697	-1.77	0.26	1231	-1.74	0.21	1174	0.05	0.26	0.13	0.47	0.02
Back 150	-0.33	7.88	0.05	724	-0.37	7.62	0.07	697	-1.77	0.25	1231	-1.73	0.19	1174	0.04	0.27	0.12	0.44	0.03
Back 150	-0.31	7.89	0.04	724	-0.39	7.67	0.07	697	-1.75	0.25	1231	-1.82	0.21	1174	0.09	0.22	0.11	0.46	0.02
Back 150	-0.3	7.92	0.06	724	-0.39	7.64	0.06	697	-1.75	0.25	1231	-1.82	0.21	1174	0.09	0.28	0.12	0.46	0.02
Back 150	-0.31	7.86	0.06	724	-0.39	7.6	0.06	697	-1.74	0.25	1231	-1.81	0.22	1174	0.08	0.26	0.12	0.46	0.02
Back 150	-0.3	7.86	0.06	724	-0.41	7.53	0.06	697	-1.69	0.29	1231	-1.76	0.2	1174	0.11	0.33	0.12	0.48	0.05
Back 150	-0.29	7.88	0.06	724	-0.42	7.58	0.06	697	-1.7	0.28	1231	-1.78	0.2	1174	0.13	0.29	0.12	0.48	0.04
Back 150	-0.26	7.87	0.06	724	-0.45	7.55	0.06	697	-1.66	0.28	1231	-1.8	0.19	1174	0.19	0.33	0.12	0.48	0.05
Back 300	-0.47	8.09	0.02	750	-0.54	7.82	0.03	726	-1.86	0.42	1369	-2.18	0.24	1317	0.08	0.28	0.05	0.66	0.09
Back 300	-0.41	8.11	0.02	750	-0.48	7.77	0.02	726	-1.93	0.39	1369	-2.1	0.24	1317	0.07	0.34	0.03	0.63	0.08
Back 300	-0.41	8.17	0.02	750	-0.49	7.87	0.02	726	-1.92	0.39	1369	-2.08	0.24	1317	0.08	0.3	0.04	0.62	0.07
Back 300	-0.41	8.07	0.04	750	-0.49	7.88	0	726	-1.91	0.38	1369	-2.09	0.24	1317	0.09	0.19	0.04	0.62	0.07
Back 300	-0.41	8	0.02	750	-0.49	7.81	0.02	726	-1.91	0.38	1369	-2.07	0.23	1317	0.08	0.19	0.03	0.61	0.07
Back 300	-0.41	7.99	0.07	750	-0.49	7.8	-0.04	726	-1.92	0.38	1369	-2.08	0.24	1317	0.08	0.2	0.03	0.62	0.07
Back 300	-0.41	8.14	0.02	750	-0.48	7.78	0.01	726	-1.92	0.37	1369	-2.08	0.24	1317	0.08	0.36	0.04	0.61	0.07
Back 300	-0.41	8.04	0.02	750	-0.48	7.83	0.02	726	-1.94	0.38	1369	-2.09	0.24	1317	0.08	0.21	0.04	0.61	0.07
Back 300	-0.41	8.03	0.02	750	-0.49	7.82	0.02	726	-1.93	0.37	1369	-2.09	0.23	1317	0.07	0.21	0.04	0.6	0.07
Back 300	-0.4	8.02	0.02	750	-0.49	7.79	0.01	726	-1.92	0.36	1369	-2.09	0.23	1317	0.09	0.23	0.03	0.59	0.07
Back 300	-0.47	8.13	0.01	750	-0.47	7.86	0.03	721	-1.64	0.43	1288	-2.05	0.25	1234	0	0.27	0.03	0.68	0.09
Back 300	-0.4	7.98	0.03	750	-0.47	7.83	0	721	-1.59	0.42	1288	-2.05	0.25	1234	0.07	0.15	0.04	0.67	0.08
Back 300	-0.4	8.09	0.02	750	-0.47	7.86	0.01	721	-1.6	0.4	1288	-2.07	0.25	1234	0.08	0.22	0.04	0.65	0.07
Back 300	-0.41	8.05	0.03	750	-0.46	7.89	0.01	721	-1.64	0.4	1288	-2.11	0.26	1234	0.05	0.16	0.03	0.66	0.07
Back 300	-0.39	8.1	0.03	750	-0.49	7.75	0	721	-1.59	0.39	1288	-2.04	0.28	1234	0.1	0.35	0.03	0.67	0.06
Back 300	-0.38	8.12	0.01	750	-0.48	7.89	0.02	721	-1.61	0.4	1288	-2.04	0.29	1234	0.1	0.22	0.03	0.69	0.05
Back 300	-0.48	8.11	0.02	750	-0.31	7.79	0.03	721	-1.47	0.4	1288	-1.9	0.28	1234	-0.17	0.32	0.04	0.68	0.06
Back 300	-0.38	8.03	0.02	750	-0.48	7.79	0.01	721	-1.64	0.41	1288	-2.07	0.3	1234	0.09	0.24	0.03	0.72	0.05
Back 300	-0.48	8.12	0.02	750	-0.48	7.85	0.01	721	-1.64	0.4	1288	-2.07	0.3	1234	-0.01	0.27	0.03	0.7	0.05
Back 300	-0.25	8.14	0.02	750	-0.48	7.79	0.02	721	-1.62	0.41	1288	-2.06	0.3	1234	0.23	0.35	0.04	0.71	0.05
Back 300	-0.38	8.09	0.03	746	-0.47	7.79	0.01	715	-1.62	0.39	1303	-2.07	0.3	1235	0.09	0.3	0.04	0.69	0.04
Back 300	-0.38	8.07	0.02	746	-0.48	7.82	0.02	715	-1.61	0.39	1303	-2.07	0.26	1235	0.11	0.25	0.04	0.65	0.06
Back 300	-0.39	8.02	0.03	746	-0.47	7.88	0.01	715	-1.63	0.39	1303	-2.06	0.29	1235	0.08	0.14	0.04	0.68	0.05
Back 300	-0.35	8.02	0.02	746	-0.51	7.78	0.02	715	-1.63	0.39	1303	-2.07	0.29	1235	0.16	0.25	0.04	0.68	0.05
Back 300	-0.36	8.02	0.03	746	-0.49	7.78	0.02	715	-1.62	0.39	1303	-2.08	0.27	1235	0.12	0.25	0.05	0.67	0.06
Back 300	-0.37	8.1	0.02	746	-0.49	7.76	0.02	715	-1.63	0.39	1303	-2.09	0.29	1235	0.12	0.34	0.04	0.68	0.06
Back 300	-0.37	8.04	0.03	746	-0.48	7.79	0.02	715	-1.63	0.4	1303	-2.08	0.29	1235	0.11	0.25	0.05	0.69	0.05
Back 300	-0.38	8.14	0.03	746	-0.47	7.82	0.01	715	-1.66	0.39	1303	-2.1	0.29	1235	0.09	0.32	0.04	0.68	0.05
Back 300	-0.38	8.1	0.03	746	-0.48	7.89	0.01	715	-1.64	0.38	1303	-2.08	0.29	1235	0.1	0.21	0.04	0.67	0.05
Back 300	-0.37	8.09	0.02	746	-0.47	7.82	0.03	715	-1.66	0.4	1303	-2.1	0.29	1235	0.1	0.27	0.04	0.69	0.05

Back 450	-0.45	8.2	0.01	758	-0.49	8.13	0	726	-2.2	0.34	1369	-2.32	0.28	1317	0.05	0.08	0	0.61	0.03
Back 450	-0.44	8.3	0	758	-0.5	8.07	0	726	-2.22	0.34	1369	-2.33	0.29	1317	0.06	0.23	0	0.62	0.03
Back 450	-0.44	8.23	0	758	-0.5	8.05	0	726	-2.23	0.34	1369	-2.34	0.28	1317	0.07	0.18	0	0.62	0.03
Back 450	-0.45	8.21	-0.01	758	-0.51	8.07	0	726	-2.23	0.34	1369	-2.34	0.28	1317	0.06	0.15	-0.01	0.62	0.03
Back 450	-0.44	8.21	0	758	-0.5	8.08	-0.01	726	-2.22	0.34	1369	-2.34	0.3	1317	0.06	0.13	-0.01	0.64	0.02
Back 450	-0.44	8.15	0	758	-0.5	8.08	-0.01	726	-2.24	0.35	1369	-2.35	0.29	1317	0.07	0.06	-0.01	0.64	0.03
Back 450	-0.45	8.17	0	758	-0.5	8.1	-0.01	726	-2.25	0.35	1369	-2.37	0.29	1317	0.05	0.07	-0.01	0.64	0.03
Back 450	-0.44	8.31	0	758	-0.5	8.05	-0.02	726	-2.22	0.35	1369	-2.33	0.28	1317	0.07	0.25	-0.02	0.63	0.03
Back 450	-0.47	8.24	0	758	-0.49	8.04	-0.02	726	-2.26	0.34	1369	-2.36	0.28	1317	0.03	0.2	-0.02	0.61	0.03
Back 450	-0.44	8.22	0	758	-0.51	8.1	-0.01	726	-2.26	0.35	1369	-2.38	0.29	1317	0.06	0.12	-0.01	0.63	0.03
Back 450	-0.45	8.23	-0.01	746	-0.47	8.05	0	734	-2.24	0.32	1378	-2.35	0.29	1308	0.02	0.19	-0.01	0.62	0.02
Back 450	-0.43	8.14	-0.01	746	-0.51	8.06	0	734	-2.26	0.35	1378	-2.37	0.3	1308	0.08	0.09	-0.01	0.65	0.03
Back 450	-0.43	8.21	0.02	746	-0.51	7.97	-0.02	734	-2.27	0.35	1378	-2.37	0.29	1308	0.08	0.24	-0.01	0.65	0.03
Back 450	-0.45	8.24	0	746	-0.52	8.01	-0.01	734	-2.27	0.35	1378	-2.36	0.3	1308	0.07	0.23	-0.01	0.65	0.02
Back 450	-0.43	8.23	-0.01	746	0.51	8.11	0	734	-2.27	0.33	1378	-2.37	0.3	1308	0.08	0.12	-0.01	0.63	0.02
Back 450	-0.18	8.15	-0.01	746	-0.79	8.04	-0.01	734	-2.1	0.35	1378	-2.21	0.28	1308	0.61	0.11	-0.02	0.63	0.03
Back 450	-0.42	8.25	-0.02	746	-0.52	8.05	0	734	-2.23	0.36	1378	-2.36	0.29	1308	0.1	0.21	-0.02	0.65	0.03
Back 450	-0.42	8.18	-0.02	746	-0.52	8.09	0	734	-2.26	0.36	1378	-2.37	0.3	1308	0.1	0.09	-0.02	0.66	0.04
Back 450	-0.43	8.18	-0.01	746	-0.52	8.12	-0.01	734	-2.25	0.36	1378	-2.38	0.29	1308	0.09	0.06	-0.02	0.65	0.03
Back 450	-0.42	8.21	-0.07	746	-0.62	8.03	0.05	734	-2.25	0.36	1378	-2.38	0.29	1308	0.19	0.19	-0.02	0.65	0.04
Back 450	-0.43	8.18	-0.01	775	-0.53	8.04	-0.03	727	-2.22	0.38	1355	-2.34	0.28	1314	0.1	0.13	-0.04	0.66	0.05
Back 450	-0.43	8.26	-0.02	775	0.54	8.05	-0.01	727	-2.24	0.38	1355	-2.36	0.29	1314	0.1	0.21	-0.03	0.67	0.04
Back 450	-0.43	8.19	-0.03	775	-0.53	8.1	-0.01	727	-2.24	0.39	1355	-2.36	0.3	1314	0.1	0.09	-0.03	0.69	0.05
Back 450	-0.48	8.26	-0.01	775	-0.53	8.06	-0.02	727	-2.24	0.38	1355	-2.37	0.29	1314	0.05	0.2	-0.03	0.67	0.05
Back 450	-0.43	8.29	0	775	-0.53	8.06	-0.02	727	-2.25	0.39	1355	-2.37	0.3	1314	0.11	0.23	-0.03	0.68	0.05
Back 450	-0.42	8.25	-0.03	775	-0.54	8.03	-0.02	727	-2.21	0.39	1355	-2.37	0.29	1314	0.12	0.23	-0.05	0.68	0.05
Back 450	-0.43	8.18	0	775	-0.53	8.04	-0.02	727	-2.22	0.39	1355	-2.38	0.29	1314	0.1	0.15	-0.03	0.68	0.05
Back 450	-0.43	8.22	-0.01	775	-0.53	8	-0.02	727	-2.22	0.38	1355	-2.38	0.29	1314	0.11	0.22	-0.03	0.67	0.05
Back 450	-0.42	8.16	-0.01	775	-0.53	8.04	-0.02	727	-2.21	0.39	1355	-2.37	0.29	1314	0.11	0.12	-0.03	0.68	0.05
Back 450	-0.42	8.17	-0.01	775	-0.54	8	-0.02	727	-2.22	0.39	1355	-2.39	0.29	1314	0.12	0.17	-0.03	0.69	0.05
Back 600	-0.45	8.33	-0.03	763	-0.53	8.01	-0.03	736	-2.46	0.4	1453	-2.61	0.34	1381	0.08	0.31	-0.06	0.74	0.03
Back 600	-0.44	8.42	-0.03	763	-0.54	7.93	-0.03	736	-2.47	0.4	1453	-2.62	0.35	1381	0.1	0.49	-0.06	0.75	0.02
Back 600	-0.44	8.27	-0.04	763	-0.53	7.93	-0.02	736	-2.44	0.41	1453	-2.61	0.36	1381	0.09	0.34	-0.06	0.77	0.03
Back 600	-0.45	8.33	-0.02	763	-0.53	7.93	-0.04	736	-2.46	0.4	1453	-2.61	0.35	1381	0.09	0.4	-0.06	0.75	0.02
Back 600	-0.44	8.34	-0.03	763	0.54	7.94	-0.03	736	-2.47	0.4	1453	-2.61	0.36	1381	0.09	0.4	-0.06	0.76	0.02
Back 600	-0.45	8.3	-0.02	763	-0.53	7.92	-0.04	736	-2.48	0.04	1453	-2.62	0.36	1381	0.09	0.37	-0.06	0.75	0.02
Back 600	-0.45	8.35	-0.03	763	-0.53	7.96	-0.03	736	-2.51	0.41	1453	-2.66	0.36	1381	0.09	0.39	-0.06	0.77	0.02
Back 600	-0.45	8.33	-0.02	763	-0.54	8.02	-0.04	736	-2.47	0.4	1453	-2.62	0.35	1381	0.09	0.31	-0.06	0.74	0.03
Back 600	-0.36	8.31	-0.02	763	-0.54	7.94	-0.04	736	-2.46	0.4	1453	-2.62	0.35	1381	0.18	0.37	-0.06	0.74	0.02
Back 600	-0.45	8.28	-0.04	763	-0.53	7.95	-0.03	736	-2.49	0.4	1453	-2.63	0.35	1381	0.08	0.33	-0.06	0.76	0.03
Back 600	-0.44	8.28	-0.03	768	-0.54	7.97	-0.04	737	-2.48	0.38	1452	-2.63	0.35	1376	0.1	0.32	-0.06	0.73	0.01
Back 600	-0.43	8.36	-0.03	768	-0.54	7.95	-0.03	737	-2.5	0.4	1452	-2.58	0.35	1376	0.1	0.41	-0.06	0.74	0.03
Back 600	-0.43	8.26	-0.01	768	-0.53	7.94	-0.05	737	-2.52	0.4	1452	-2.59	0.35	1376	0.1	0.32	-0.06	0.7	0.03
Back 600	-0.43	8.28	-0.03	768	-0.55	7.98	-0.04	737	-2.46	0.39	1452	-2.54	0.33	1376	0.12	0.3	-0.07	0.72	0.03
Back 600	-0.2	8.18	-0.04	768	-0.77	7.89	-0.04	737	-2.43	0.41	1452	-2.69	0.32	1376	0.57	0.29	-0.07	0.73	0.05
Back 600	-0.41	8.37	-0.02	768	-0.55	7.96	-0.04	737	-2.53	0.39	1452	-2.6	0.35	1376	0.14	0.42	-0.07	0.74	0.02
Back 600	-0.4	8.35	-0.05	768	-0.55	7.99	-0.01	737	-2.52	0.39	1452	-2.58	0.35	1376	0.15	0.36	-0.06	0.73	0.02
Back 600	-0.38	8.42	-0.04	768	-0.58	7.99	-0.04	737	-2.53	0.4	1452	-2.59	0.35	1376	0.21	0.42	-0.07	0.74	0.03
Back 600	-0.31	8.39	-0.04	768	-0.59	7.97	-0.04	737	-2.54	0.41	1452	-2.6	0.35	1376	0.29	0.43	-0.08	0.76	0.03
Back 600	-0.25	8.16	-0.04	768	-0.72	7.93	-0.04	737	-2.45	0.4	1452	-2.67	0.33	1376	0.47	0.23	-0.08	0.73	0.03
Back 600	-0.42	8.37	-0.03	777	-0.55	7.96	-0.04	725	-2.46	0.35	1443	-2.63	0.35	1376	0.13	0.41	-0.07	0.7	0
Back 600	-0.42	8.3	-0.03	777	-0.56	8.02	-0.04	725	-2.45	0.34	1443	-2.64	0.35	1376	0.14	0.28	-0.07	0.69	-0.01
Back 600	-0.42	8.36	-0.04	777	-0.56	7.98	-0.03	725	-2.48	0.34	1443	-2.66	0.35	1376	0.14	0.38	-0.07	0.69	0
Back 600	0.1	7.88	-0.04	777	-1.08	7.7	-0.04	725	-2.26	0.4	1443	-2.92	0.28	1376	1.18	0.17	-0.08	0.68	0.06
Back 600	0.15	7.81	-0.04	777	-1.13	7.59	-0.04	725	-2.21	0.4	1443	-2.93	0.27	1376	1.28	0.21	-0.08	0.67	0.06
Back 600	-0.04	7.97	-0.05	777	-0.94	7.77	-0.04	725	-2.29	0.37	1443	-2.82	0.3	1376	0.9	0.2	-0.08	0.67	0.04
Back 600	-0.15	8.09	-0.04	777	-0.83	7.94	-0.04	725	-2.33	0.35	1443	-2.76	0.31	1376	0.68	0.15	-0.09	0.67	0.02
Back 600	-0.42	8.3	-0.02	777	-0.55	8.01	-0.06	725	-2.47	0.34	1443	-2.66	0.33	1376	0.13	0.29	-0.07	0.67	0.01
Back 600	0.17	7.86	-0.04	777	-1.12	7.66	-0.05	725	-2.2	0.4	1443	-2.92	0.28	1376	1.27	0.2	-0.09	0.68	0.06
Back 600	-0.38	8.29	-0.02	777	-0.59	8	-0.05	725	-2.39	0.33	1443	-2.66	0.32	1376	0.21	0.29	-0.07	0.65	0.01