Suspension Issues
Berkeley Formula Racing

A Design Doc

by

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Abstract

This document describes the issues that I, Jason Cheung, find with the suspension system of the 2015 FSAE Car, B15.

The main issues with the suspension system is that the setup takes a long time to complete, and the setup measurements are inconsistent between people.

Contents

1 Suspension Setup

1.1 Ride Height

Current Method

Measuring ride height consists of using a **very specific 6 inch long square** called the "Suspension Ruler" to measure from the ground to the bottom of the front lower a-arm tabs for front ride height, and from the ground to the bottom of the rear bulk head for rear ride height.

Issues

The front body panels of the car are curved, such that the a-arm tab that we measure is inset farther towards the center of the car. This means that if the rule is perfectly vertical, the **top of the ruler contacts the body panel, and the ruler cannot physically touch the tab**, leading to less accurate measurements.

With the front wing on, it is not physically possible to fit your head down low enough to read the ruler parallel to the bottom of the tab. A solution I came up with is using a camera to take a picture parallel to the reading, and tab.

Tightening the shocks enough is difficult as two shock tools cannot fit on either the front or the rear shocks. It is currently done by holding one shock adjustment spinner with your finger, and using 1 tool with the other hand. **This is inaccurate as if the height of the camera changes, the reading changes.**

Solutions

This is Jun's idea. To have a tab sticking horizontally out of the car as the measuring point. Some sort of block will have slits cut into it at the proper ride height. Set the block on the floor, if the tab fits into the slit, it is at the proper ride height.

Potential problem: Only tells us if the ride height is correct, not how much it needs to be adjusted

1.2 Cross Weight

Issues

Not communicated that the scales must be level between each other. **There is a specific level that must be used** in order to level the scales, and **even that cannot reach the front scales to rear scales, meaning that the scales must be moved closer to each other than wanted**

Solutions

I have seen another team use graduated cylinders connected with a tube, and use the height of the water to level the scales.

Potential problem: Only tells us if the ride height is correct, not how much it needs to be adjusted

1.3 Toe

Current Method

Use 2 toe gauges that must be held onto the lips of the wheel by hand. 2 tape measures run from toe gauge to toe gauge.

People Required

1. Holds the toe gauge with the ends of the tape measure taped to the gauge
2. Holds the toe gauge on the measuring end of the tape measures
3. Tensions the tape measure, and reads the length
4. Adjusts the tie rods until the measurement is proper
5. (optional, saves time by 25% so 1 person does not have to read both) Tensions the 2nd tape measure, and reads the length

Issues

There is no way to properly measure absolute toe (Toe in relation to the car)

Takes too many people to do. Ideally it should take 2 people.

Solutions

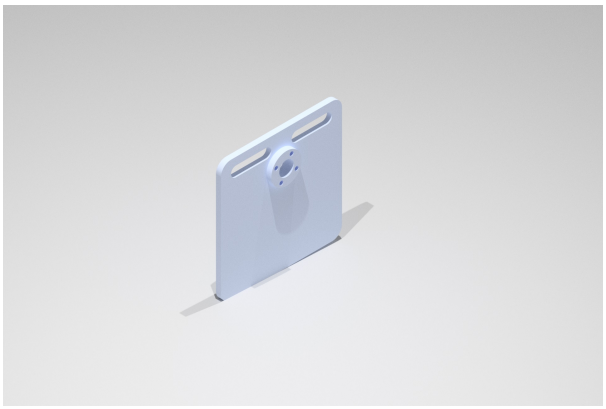

Figure 1.1: Alignment Plate

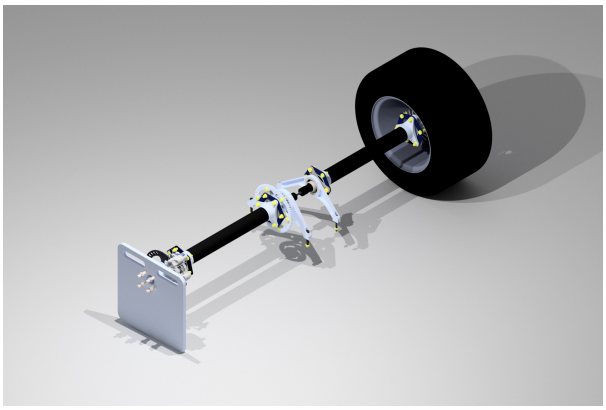

Figure 1.2: Alignment Plate on Car

This is Kettering's solution. Have a plate that fits onto the wheel center and 4 wheel bolts. **This plate must have the same height as the wheel, and same width as the wheel.**

Relative Toe

Measure from rear of one plate to the rear of the other plate, and measure from the front of one plate to the front of the other plate.

Absolute Toe

Measure from front of one plate to the rear of the other plate, they should be the same.

1.4 Camber

Current Method

Measurement

Zero the camber gauge on the ground near the wheel. Put a bolt through the toe gauge, through 5-6 shims, then bolted into the camber gauge. Rest the toe gauge on the wheel.

Adjustment

Lift the car up on a block, take off the wheel(s), loosen the upper ball joint, add or remove shims based on the reading. (0.3 degrees is a 0.030 thick shim).

Issues

Inaccurate because how much the camber gauge is tightened onto the toe gauge changes how much the camber gauge droops, and will change the reading. Ideally the bolt would be infinitely tight, so the camber gauge is perfectly horizontal with the ground.

Solutions

Using the plate mentioned in the toe section will cause reading camber to be more uniform across different readers

Possible Issues Unsure how the car sitting on 2 plates instead of wheels will affect camber.

2 Ease of Wrenching

Difficult to get to go and difficult to see bolts often go **unchecked** by inexperienced team members.

2.1 Jam Nuts

Push Rods

- Wheel-side: **Easy**
- Car-side: **Easy**

Tie Rods

- Wheel-side: **Very Difficult**

  There is only 1 7/16th wrench that is able to tighten the wheel-side jam nut. And only I have been able to do it easily since I have "mastered" twisting the tie rod to angle the wrench properly.

- Car-side: Front: **Easy-Medium**
  Rear: **Easy**

  The front tie rods can only be reached by reaching both arms into the cockpit

ARB

- Front: **Easy**
- Rear: **Easy**

Summary

It is extremely difficult to get to jam nuts inside the wheel. All others are fine.

3 Conclusion

A lot of Suspension setup requires tricks from people who have done it before. This means it is hard for less experienced people to complete the setup.

Jam nuts should to be easier to get to.