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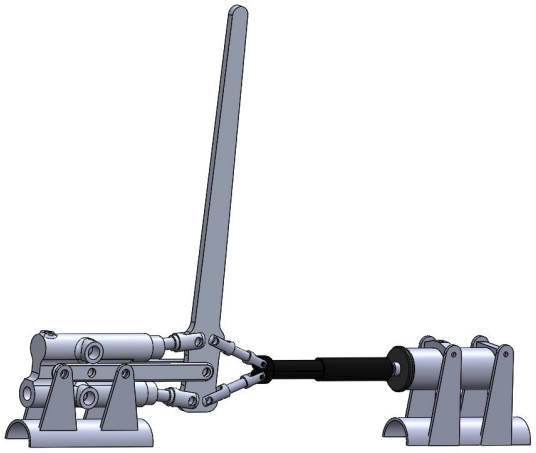
Brakes subteam
Spring 2016 Tech Report -Rotors and Cutting Brakes

Overview

Last semester my only responsibility was working on the brake rotors for the car. Once I finished the design and sent them out to be fabricated, I took over the responsibilities for ensuring that the cutting brakes were built, assembled, and placed on the car. The cutting brakes had already been designed by Kyle Gregory in the fall semester. This semester served primarily as a learning experience and an opportunity to understand how the whole brake system works. Throughout the semester I also improved my skills in the machine shop, learned how to bleed brakes, the hydrolics of the car, and how to recognize issues and solve them. I've become a much more experienced baja member and no longer feel lost when anything other than the brake system is brought up.

Brake Rotors

There have been no improvements to the brake rotors since first semester. This semester I focused primarily on the cutting brakes, but would occasionally check the rotors to see if there was any deflection or wear. The primary concern was ensuring that the rear rotors were strong enough to withstand the braking force applied by the cutting brakes which is a fairly new addition. Last year this was not accounted for the rear rotors failed (Shown in the image to the right). This year was the first year where we had fully customized the cutting brakes. The FOS for OD12's rear rotors were determined using hand calc (Check my tech report from Fall 2015). During competition this year one of the rotors was torn off the hub, but we determined that it was not caused by the design of the rotor. We also haven't encountered any issues from previous years such as dirt and debris getting stuck in the rotor slots or deformation of the rotor.



Cutting Brakes

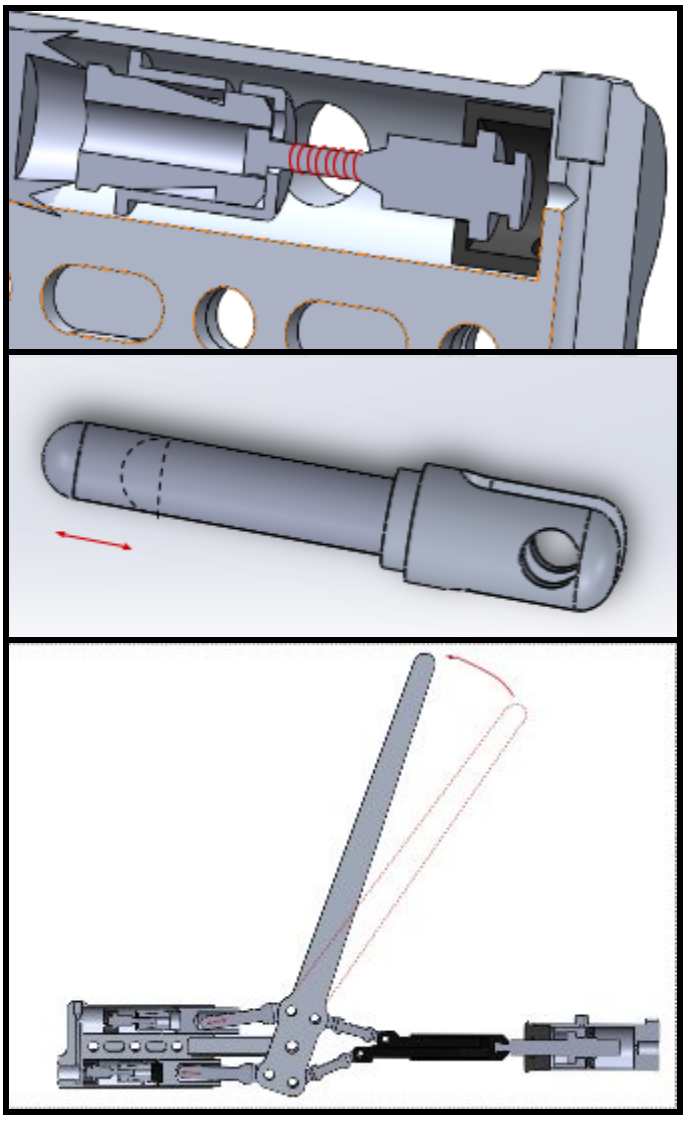
<u>Adjustable positioning</u>

I dedicated the first few weeks of the semester to machining, understanding the cutting brakes, and learning the concepts behind fluid dynamics. There were a few issues with the cutting brakes considering it

was the first time that this design had been implemented. Initially we weren't sure how to place the diff unlocker relative to the cutting brakes to achieve the optimal distance. To guarantee that we didn't weld tabs in the wrong spot, we developed a mechanism that would allow us to modify their separation. Eight makeshift tabs were welded to two half tubes with inner diameters equal to the diameter of the floor bar. We then used hose clamps to secure the half tubes to the floor bar, adjusting them after testing. This trial and error method proved to be effective.

Missing spring

When making the CAD for the cutting brakes Kyle chose to exclude the spring needed to force the face seal to seal against the rest of the reservoir. When the the driver applied the cutting brakes, the cutting brake would just displace the fluid into the back part of the cylinder where the clip was before it was displaced, making the system useless. While I had only seen the internals of cutting brakes in the CAD, I had to figure out the problem. That required me to develop a full understanding of the cutting brakes. I included the missing spring in the diagram in red. Luckily it was an easy fix.

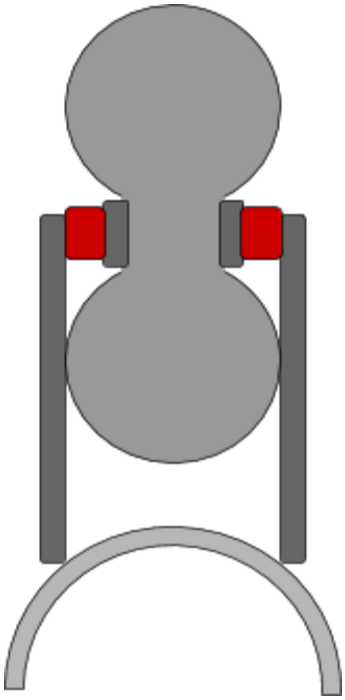


Increased push rod length

We also had to consider the driver's comfort which is hard to do unless the cutting brakes were on the car. Our driver wanted the cutting brakes to be more responsive so we increased the length of the push rod so that the face seal would isolate the system to only the chosen calliper. In the diagram to the right, the red dotted lever was the lever's original displacement with the shorter pushrods. Furthermore, the driver wanted the lever to be longer than what we had originally designed. We remade a longer lever which he was comfortable with. This did add more weight to the cutting brakes than we had originally designed them to be. Considering we were under time constraints, this was the most practical solution. But this raises questions about the design that could significantly reduce the weight. This will be discussed further later on.

Cutting Brake and Diff Locker/Unlocker integration

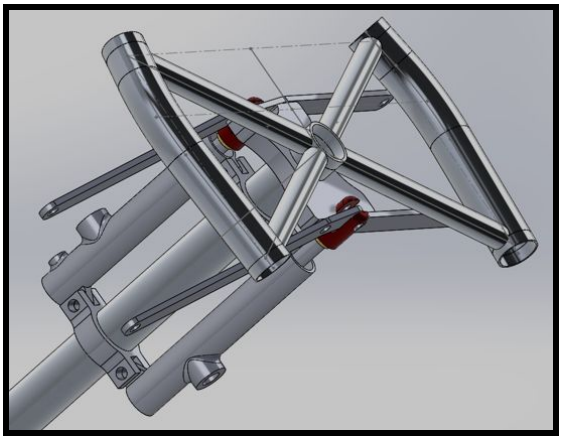
Another new addition to the car was combining the Cutting Brakes and the diff unlocker into one system. That way when you push/pull the lever, you unlock the diff simultaneously. The idea was that you didn't have to unlock the diff and then hit the cutting brakes which greatly simplifies the system for the driver. This is important when the driver wants to use the cutting brakes in the middle of a race, but with this configuration, the driver needs to press the master cylinder at the end to remove the face seal. Regardless, this was a better system than having separate systems in a race. Furthermore, the diff wasn't functioning properly and was unable to lock after unlocking it mostly due to friction inside the cylinder. This was an issue separate from the cutting brakes, but considering they are connected it's worth mentioning. Look into Jordan Wakser's tech report for further detail.



Design for machinability

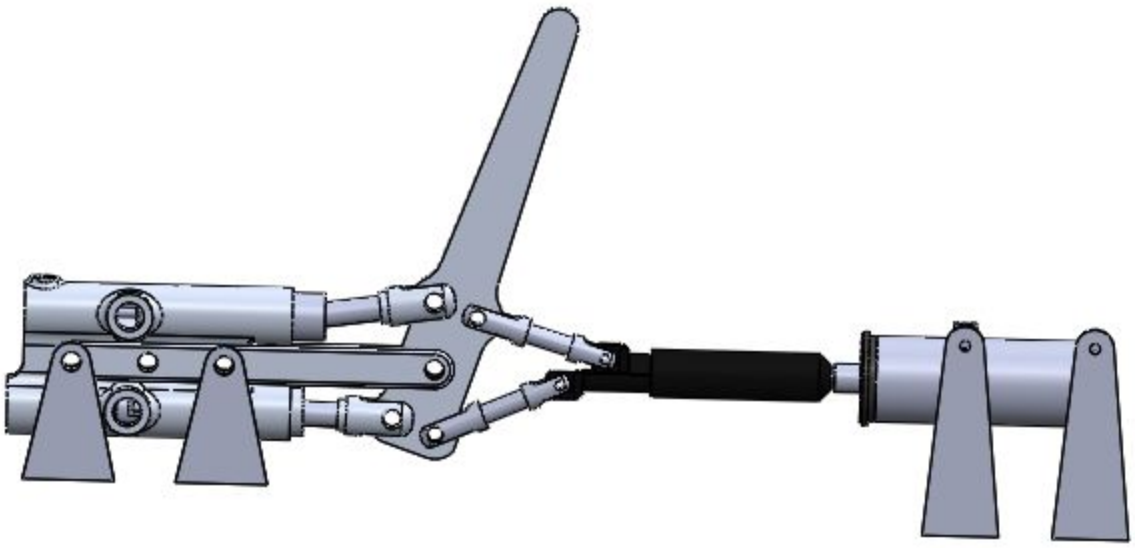
The biggest problem with the cutting brakes this year is that they weren't designed for machinability. It also wasn't designed appropriately to be mounted to the tabs and frame floor bar. We had to place spacers between the tabs and the cutting brakes that were not initially included in the design. The diagram to the right shows cutting brakes from the back, with the red spacers representing the spacers. There were also a few other adjustments we had to make based on what drill bit sizes were available etc… This is an important thing to consider in order to avoid wasting time during the second semester.

Ideas for next year



Considering the Cutting Brakes are a new addition to the car, there is still a lot of room for innovation. Now that we got the cutting brakes working, we can focus on optimization and customization. Grabbing the lever when you want to apply the cutting brakes requires you to take a hand off the steering wheel, which isn't ideal, especially when making a sharp turn. Kyle suggested attaching two handlebar levers to replace the lever. This proposed some logistical problems running the brake line along the steering shaft. I believe that if more thought was put into this idea it could be a possibility. Perhaps having the cutting brake housing on the floor and have a mechanical system that allows the handle bar levers to actuate the

brakes (wire?). We also currently have a big piece of metal as our lever which could be reduced. Ideally next year we would measure the length needed to acquire the appropriate mechanical strength. If we realize that the lever could be shorter, we could raise the whole system up on the frame and put a shorter lever (shown in the image below). For the system to work, the diff needs to unlock before the cutting brakes are applied, so it would be worth investigating new ideas that would ensure that. Ultimately most design changes require an accurate value for the force needed to actuate the cutting brakes/ unlock the diff. The calculations made last semester did not reflect forces that were required. With this knowledge, we can figure out what design works best.



Machining

This semester I spent most of my time on baja in the machine shop. I drastically improved my skills with the mill and lathe. I learned how to use different tools that allowed me to make more complicated pieces. I also became more adept at understanding the controls on the lathe and mill and what speed to use with different metals or operations. A few weeks before competition we fell behind in production, so I made an effort to get other freshmen to help make simple pieces that needed to be made. This gave me some leadership and organizational skills.