*Centric Parts*
*21046 South Figueroa Street*
*Carson, CA 90745*
*Phone: 310.218.1091*
*tech@centricparts.com*

# *TECHNICAL WHITEPAPER:*

# *Rear Brake Upgrades:*

## *Is Bigger Really Better?*

One of the most common questions received from new owners of our front brake upgrade kits is "Do I now need to upgrade my rear brakes too?" To answer this, we need to look at the role of the rear braking system from a few different perspectives. The answer may surprise you, especially hearing this from a company that sells big brake upgrades!

## Rear Brake 101

One of the many design factors that goes into the development of a base braking system is the mysterious "bias" or "balance." Truth be told, it's a pretty simple concept to grasp: for vehicle stability under braking, it is required that the rear brakes do NOT lock before the front brakes. Simple, right? Most of you probably knew that already.
OK, so what governs the 'lock up' point of the rear brakes? Drum roll, please:

1. Tire tractive capability (friction)
2. Tire normal force (weight on the tire)

This can be proven from looking that the fundamental relationship for maximum sustainable tire force: $F=\mu N$, where:

- F = the lock up point, or peak force
- $\mu$ = tire-road coefficient of friction
- N = normal load sitting on the tire

So, when the OEM is designing a brake system, they 'size' the system components (calipers, master cylinder, rotor OD, etc.) to generate the proper amount of torque at both ends of the vehicle so that the front brake force ('F' above) exceeds its peak traction first. At this point, the front brakes lock and the car slides in a nice, stable straight line. (Note that at STOPTECH, we design our front brake upgrade kits in the very same fashion for the very same reasons.)

## Potential Impacts of Big Front Brakes

Fortunately (from a safety standpoint anyway), when most big-brake suppliers adapt a mondo rotor and caliper package to a vehicle, they end up actually increasing the FRONT bias. How? By increasing the effective caliper piston area and the rotor effective radius, these two factors work together to increase the 'mechanical gain' of the front brakes, building more torque for the same pressure, everything else being equal. So, from a bias perspective we are not pushing the vehicle toward instability, but rather just the opposite - we are underbraking the rear axle! The obvious impact would be an increase in stopping distance - probably the one thing the new owner was actually hoping to reduce. Ironic. So, say you chose to install these big brakes on the front axle but want to maintain the OEM bias. What's the answer? Well, one way would be to invest in big rear brakes too which increase the rear mechanical gain to the point that the system is balanced once again.

## So, What's the Harm in Doing That?

Well, let's look at why we upgraded the front brakes in the first place. Contrary to popular belief, the real reason sports- and racing cars use big brakes is to deal with heat. Period. There has been a bunch of stuff published which will disclaim this, but when you look at the braking system from a design standpoint, making them 'bigger' doesn't fundamentally do anything for stopping distance. It's all about the heat. So, you upgraded the front brakes because of thermal concerns but as a hidden surprise got a shift in brake bias. As a band-aid to this condition, you now spend thousands more on a rear brake upgrade because the front system was not sized correctly in the first place. Sure, it looks great, but there is another option...

## Which Is?

When upgrading your front brakes, it is possible to size the caliper pistons and rotor effective radius to maintain the original brake system's pressure-torque relationship. Yea, it takes more engineering know-how and you can't sell the same part to everyone anymore, but you are not altering the base brake balance from what the OEM intended. This design philosophy stands behind every brake upgrade kit StopTech manufactures. Now, if you sized the front brakes correctly, why would you need to change the rear brakes? Good question. If there are no thermal concerns with the rear brakes (and on a front-engine street car there rarely are) then by installing a rear big-brake kit all you are doing is (a) spending money and (b) adding unsprung weight. This is not usually viewed as favorable, unless you like driving a heavy, expensive car.

## Oh Yeah – One More Thing…

Finally, under an OEM bias condition, the rear brakes only contribute about 15-20% of all the braking force the vehicle generates, and when you install sticky tires you actually DECREASE the amount of work they need to do. Why? Because at the higher deceleration levels afforded by race tires, there is more weight transfer taking place, reducing the normal force on the rear tires and increasing it on the front (remember F=μN from above?). If anything, we now want to decrease the rear effectiveness. Ironic once again.

Of course, if you decide to upsize your rear brake system components you can also impact the front-rear torque relationship, and consequently you can "bias" the "balance" more toward the rear. Go too far, and the rear brakes could lock before the fronts. Again, not the end result you were expecting, right?

It has been said that "The folks at StopTech should consider developing a rear kit to match their front setup. They'll be very happy with the performance improvement if done properly." Well, since our FRONT systems are designed properly, we save you the need to spend your money on the back axle.

Let's reword that quote to reflect the StopTech philosophy: "Our competitors should consider developing a FRONT kit to match their stock bias condition. They'll be very happy with the performance improvement if done properly, AND will save their customers the cost of a rear brake upgrade in the process."

**by James Walker, Jr. of scR motorsports, exclusively for StopTech**

James Walker, Jr. is currently the supervisor of vehicle performance development for brake control systems at Delphi Energy & Chassis. His prior professional experience includes brake control system development, design, release, and application engineering at Kelsey-Hayes, Saturn Corporation, General Motors, Bosch, and the Ford Motor Company. Mr. Walker created scR motorsports consulting in 1997, and subsequently competed in seven years of SCCA Club Racing in the Showroom Stock and Improved Touring categories.

Through scR motorsports, he has been actively serving as an industry advisor to Kettering University in the fields of brake system design and brake control systems. He also serves as a brake control system consultant for StopTech, a manufacturer of high-performance racing brake systems. In addition, Mr. Walker contributes regularly to several automotive publications focusing on brake system analysis, design, and modification for racing and other high-performance applications. He is a recipient of the SAE Forest R. McFarland Award for distinction in professional development/education. Mr. Walker has a B.S. in mechanical engineering from GMI Engineering & Management Institute.

To find out more about Mr. Walker and scR Motorsports, visit their website at www.teamscR.com

STOPTECH

Stoptech is the performance engineering and manufacturing division of Centric Parts. It is the leader in Balanced Brake Upgrades for production cars and has three patents in basic brake technology and one other pending. With a worldwide network of resellers, StopTech's product line includes Balanced Brake Upgrades for approximately 450 applications featuring StopTech's own six-, four- and two-piston calipers, two-piece AeroRotor Direct Replacement Kits, braided stainless steel brake lines and slotted and drilled original-dimension rotors. StopTech also stocks a wide range of performance brake pads. The company's website, www.stoptech.com, is a clearinghouse of performance brake information, and provides details on StopTech products.

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