Braking System Modification, Tornado GT40 in Texas

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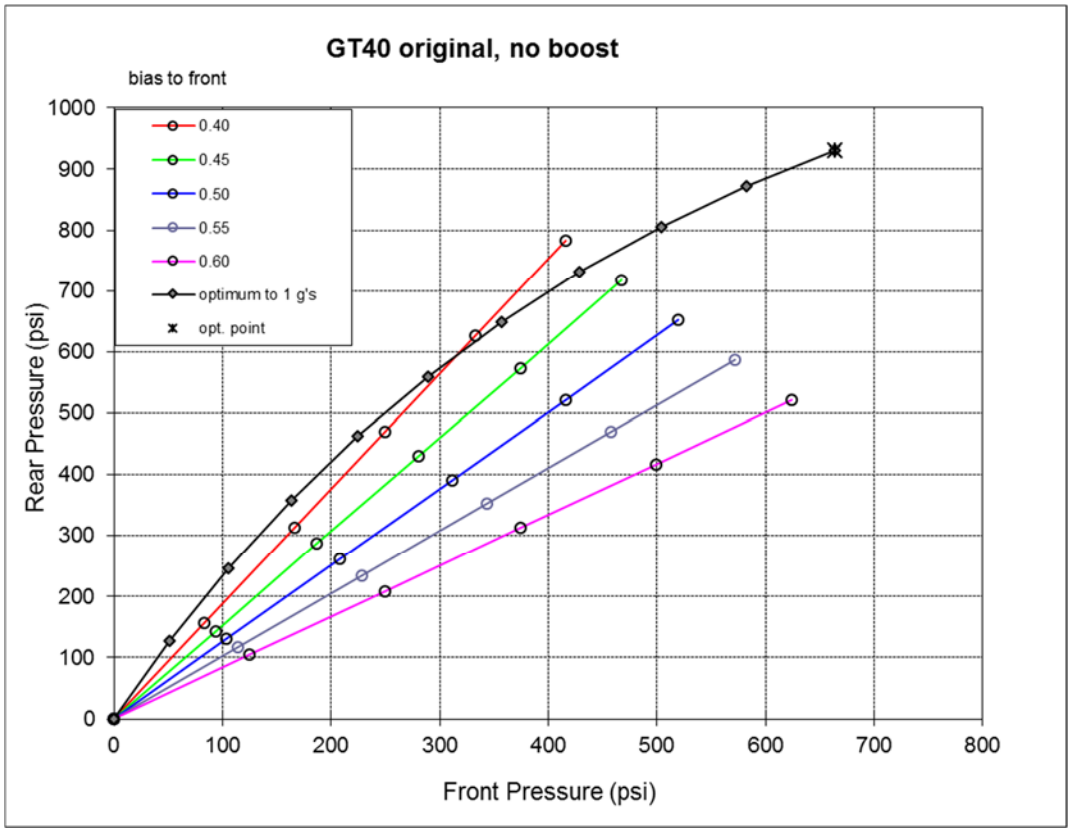
The original brake system from Tornado had the following:

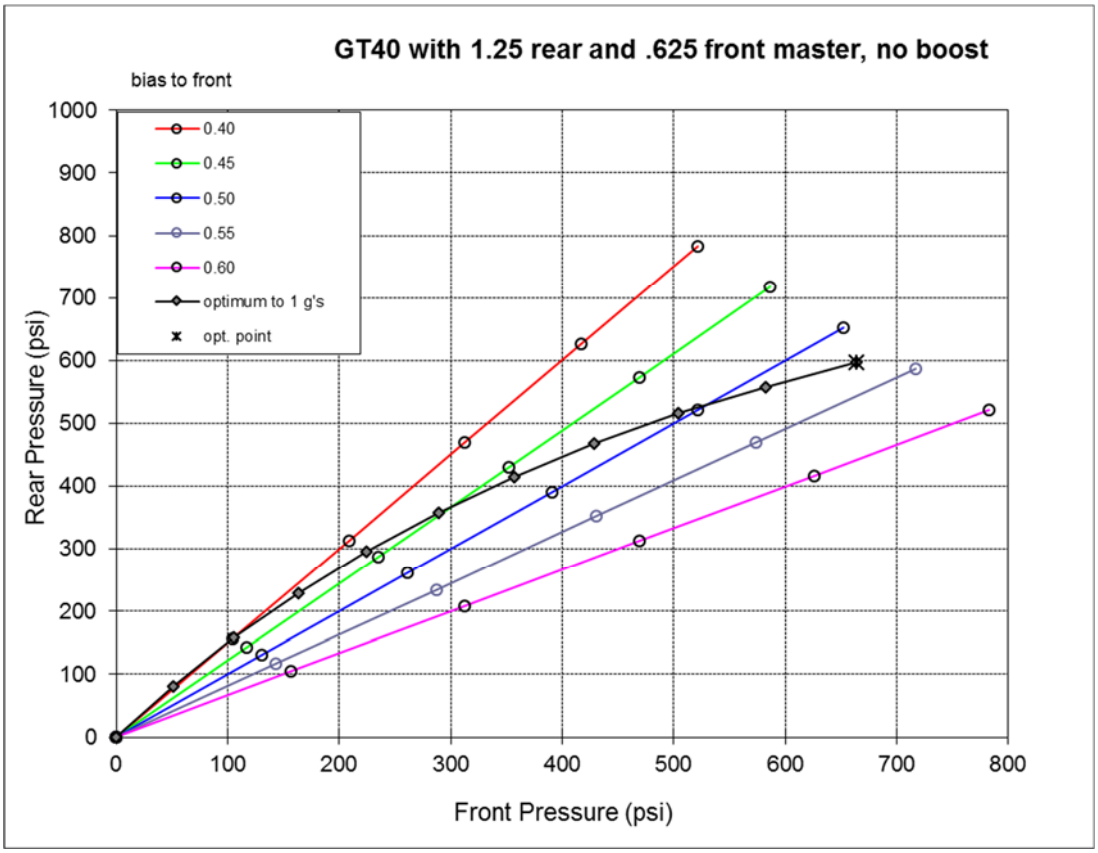
Front: Master cylinder = 0.700” diameter
Caliper = 4-piston 1.50” diameters
Rear: Master cylinder = 0.625” diameter
Caliper = 4-piston 1.00” diameters
Parking brake: Integrated in rear caliper
Pedal lever ratio = 4:1
I had to replace the 3” push rod with a 3.7” push rod to get more pedal stroke.

In the graph below, the front and rear pressures are plotted as a function of the pedal force from the foot ranging from 20 to 100 in steps of 20 pounds (100 pounds force on the pedal is a reasonable goal for max braking). This is shown by the connecting the diagonal circles. The fan of lines represent the bias bar setting going from 40% to the front (top line) to 60% to the front. The black line represents the optimum brake distribution based on weight transfer. As braking g’s increase, less pressure is required in the rear calipers, thus this curve decreases with braking g’s. A reasonable expectation for braking g’s for this car is 1.0. Each dot on this line represents 0.1 g’s increments. Thus, the top point with the X represents the best operating point of 1.0 g’s braking. As you can see, 100 pounds at the foot can only provide about 0.7 g’s of braking and will not lock the tires.



The above graph is the pressures without the vacuum boosters. If the vacuum boosters did work, they would multiply these pressures by 1.9. This make the possibility of getting pressures way in excess of 1000 psi which is too high for brake pressures. As it turns out, my boosters do not cause any boost in hydraulic pressures. They either don't work, or most likely I don't create enough vacuum in my engine. I have a relatively large cam and the maximum vacuum I can get is 40 kPa vacuum. Although I leave the vacuum boosters connected to vacuum, I have disconnected the vacuum line and did not notice any difference in braking.

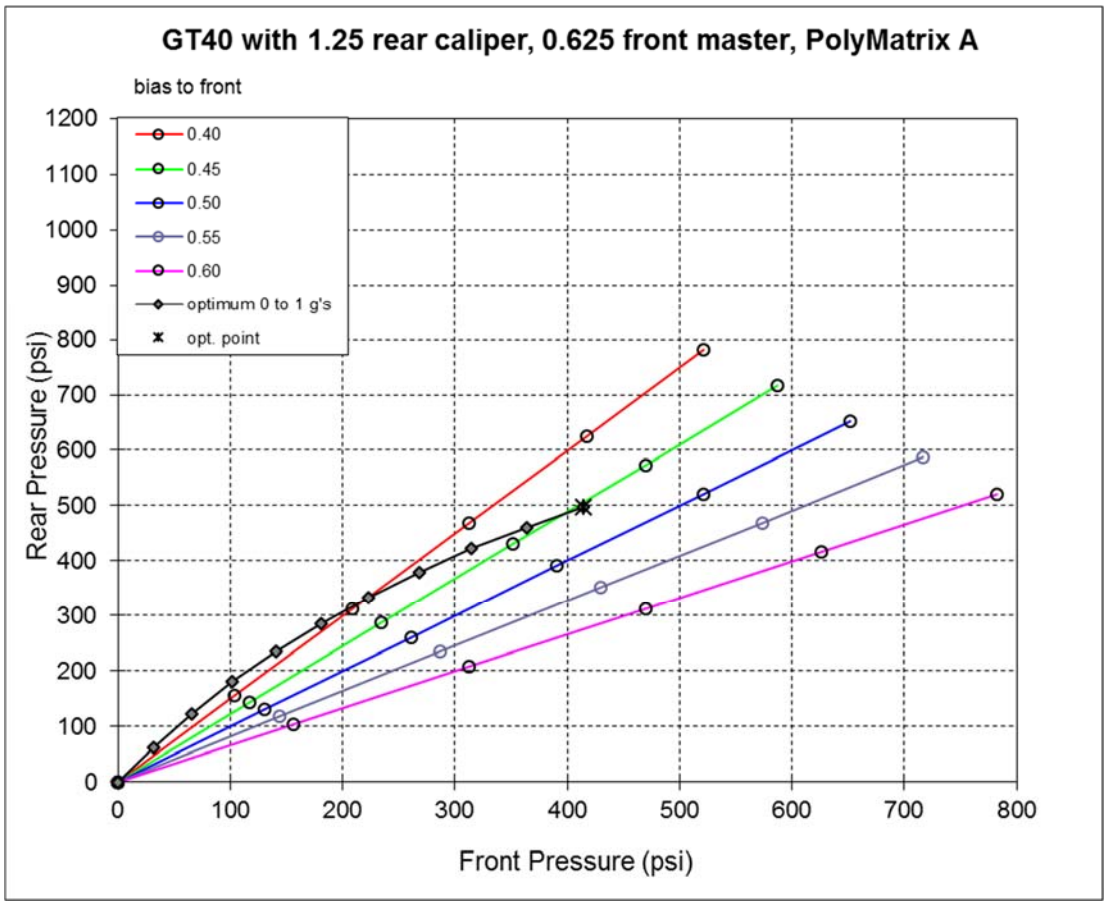
With this original setup, I could not come close to locking the brakes. My next step was to decrease the front master cylinder from 0.700" to 0.625" to get more pressure in the front and increase the rear caliper from 1.00" to 1.25" piston diameters to get more braking in the rear. I used the 4-piston 1.25" diameter piston Wilwood 120-8728 caliper. This resulted in the following graph.



Notice now that I get 1 g's of braking with 100 pounds of foot force with a bias bar setting close to 50%. With this setup I could lock the tires, but it still took a lot of force from the foot. On the track, I don't want to have to hit the brakes that hard quickly. So my next step was to replace the pads.

I think the original pads were Wilwood 150-8813K-B10. These pads are specified as "street performance / racing". They have a coefficient of friction ranging from 0.40 to 0.46. All of the preceding graphs were calculated with this pad. I switched to 150-8813K-PolyMatrix A. These

pads have a coefficient of friction ranging from 0.63 to 0.68 after an initial warmup. These pads are specified as “high-temperature racing pads”. The graph below is the same as the previous graph with the new pads.

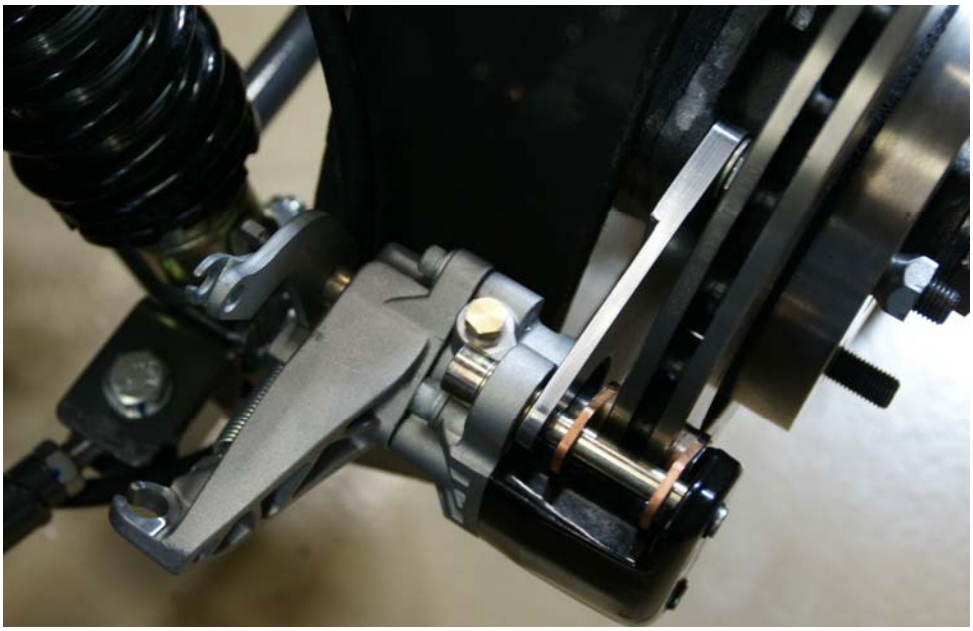


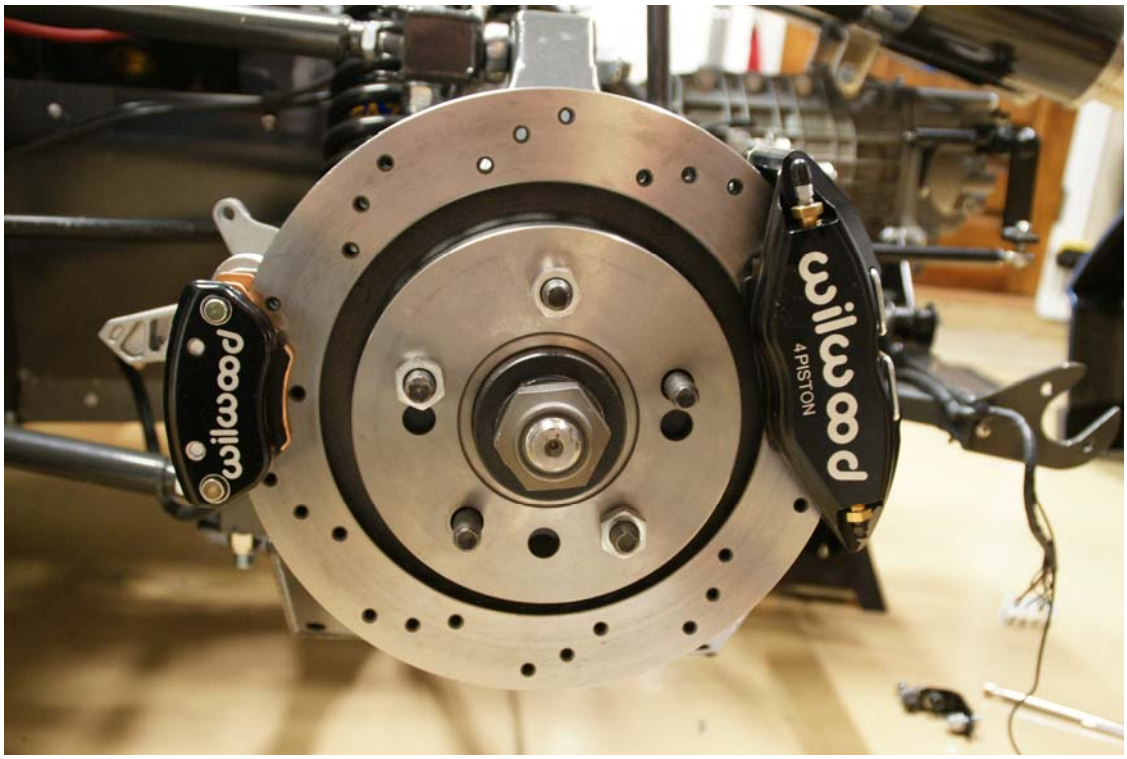
This graph shows that I can achieve 1.0 g’s of braking at 70 pounds from the foot with 45% bias bar to the front. Now I can lock the tires easily.

I’m now happy with the braking performance; however, the PolyMatrix A pads give of a lot of brake dust. The B10 pads did not. This is a bit of a concern since I need to clean the wheels after every spirited driving, but perhaps that is an acceptable tradeoff for the performance and safety.

Next is the problem with the parking brake. The original rear calipers had a cable-operated parking brake integral to the caliper that simply pushed on the existing pads. That was a particularly tidy application, but I couldn’t find the same thing with larger pistons. Therefore, I had to go with a stand-alone rear parking brake. I found a Wilwood cable-operated parking brake shown below. It is the MC4 Mechanical part number 120-12070-BK.

I had to modify the cable mounting points and build some adapters, but easily converted the hand-operated brake lever and cable to operate the MC4. I also had to build a special bracket to hold the parking caliper.





I used the fabricated parts to install the cable to the new parking caliper.

The parking brake seems to hold the car adequately. I will be happy to share more details and drawings if you follow this path.