Brake Calculations

Before getting into these calculations I've got to point out a few things. Please bear in mind that they may not (and probably won't) transfer directly to your car. My car is modified with 15" wheels, 195/50 & 205/50 tyres and higher rated suspension front & rear, so the braking performance will be different from someone with standard wheels and tyres. Even the brake pad materials you use front & rear can have a significant effect on how the car balances and which end locks first.

So just take the principles as ideas to work from and improve as you see fit.

Right, so how much improvement can you get from just putting a larger diameter disc in there ?

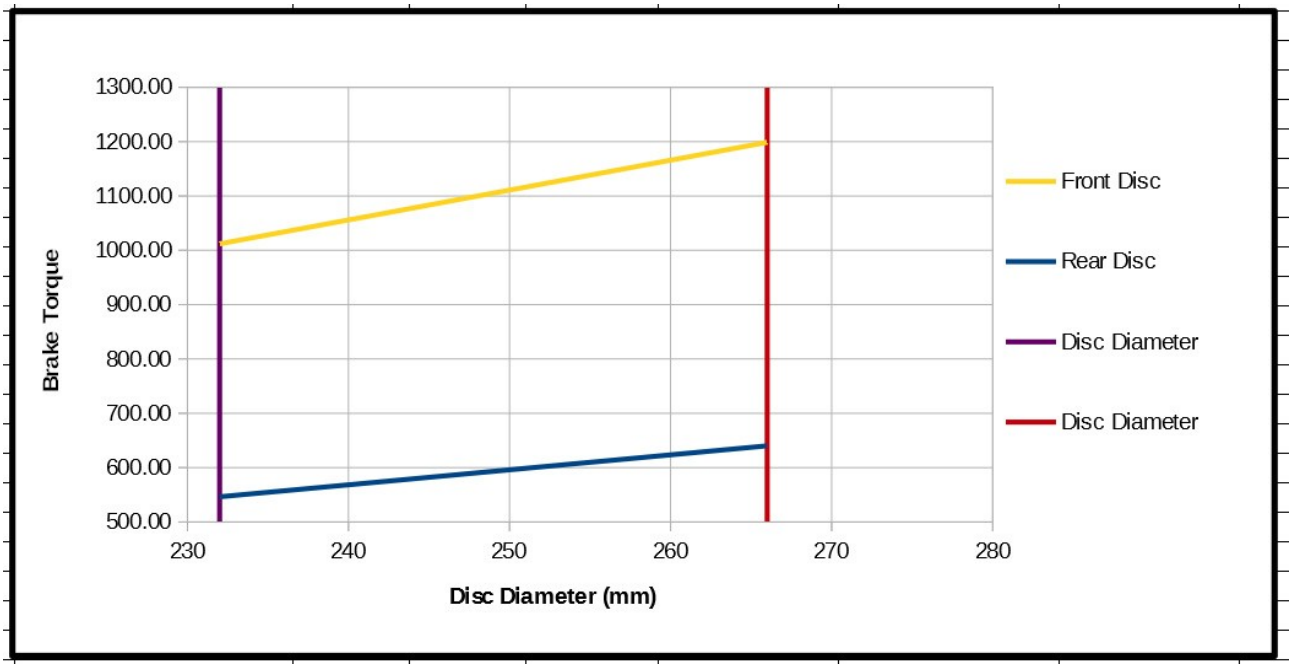

Fig 1 : Disc Brake Torque

Fig 1 shows the brake torque for a given pedal pressure (70psi) on both front & rear discs over a range of disc diameters. The two vertical lines show the 232mm OEM disc and the 266mm proposal. That's quite a jump in available torque and perhaps too much ? Can you ever have too much ? We'll check that later.

Although not indicated by vertical lines the same graph is used for the rear discs in which case you would have lines at 240mm & 259mm. There is still an improvement but doesn't look as impressive in terms of outright numbers. I tend to disregard the numbers and look at percentages in which case the overall Front/Rear imbalance isn't as much as you might think from first glance (+18%F, +10%R)

But it's still a greater increase at the front than rear. We need to see if this upsets the balance of the car under dynamic loads, and to do that I used a modified version of Richard's spreadsheet from the Yahoo group. The results are shown in Fig 2. below.

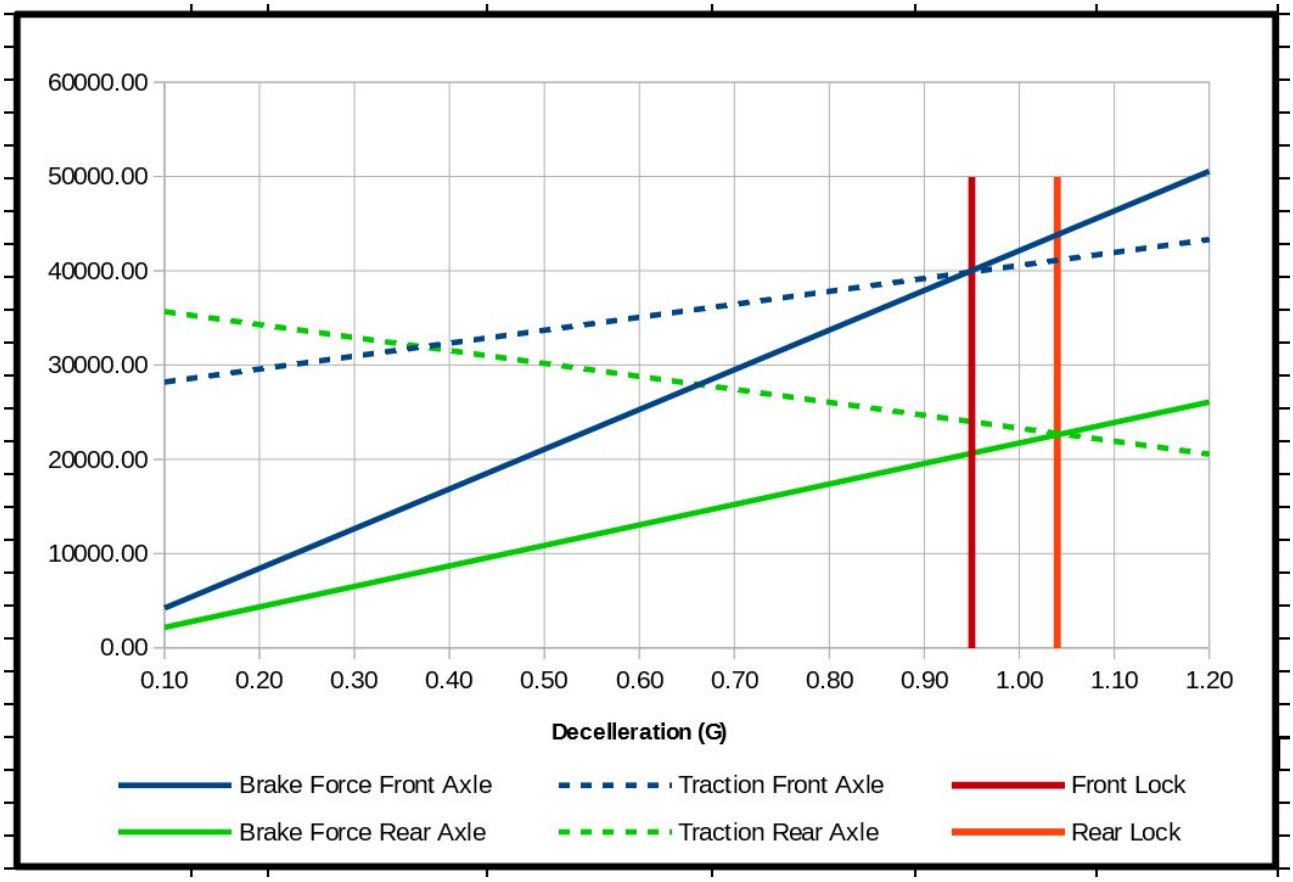

Fig 2 : Brake Performance

This graph is trying to compare the brake forces required at the front & rear axles over a series of deceleration rates with the traction forces at the axles. Now I'll come clean and admit that I didn't work this out, I used the template with a few additions from Fred Puhn and my own car data.

The X axis has the deceleration rates given as "G" and most sports cars can pull between 0.8G and 1.2G. I found road test reports varying between 0.93G and 1G for the Europa. Actual numbers depend on lots of things, frictional surfaces, tyres, etc, so don't take the numbers in this graph as gospel truth, I was only interested in the comparison between front & rear brakes.

As you brake harder you transfer more weight from rear to front, increasing front traction and reducing rear traction. What you don't want to happen is that you transfer so much weight forwards that the rear tyres lose traction and the rear wheels lock before the front. This could come about by having a rear piston area or rear disc diameter larger than required.

So, with this disc combination we have theoretical lock at 0.95G Front, 1.05G rear.

In comparison, on the same assumptions the 232mm disc/rear drum OEM set up gives 0.8G front but no lock up at the rear, which probably explains the ease with which you can lock up the standard Europa brakes if you're not careful. The S2 is different of course but similar in principle.

The 232/240mm disc combination I had previously came out at 0.93G Front, 1.04G rear, quite similar.

I must reiterate, please don't take these numbers as the absolute truth. There are so many assumptions involved, road/tyre friction, brake pad friction, etc. The value is in the comparison of front and rear, not the actual G numbers.

Costs & Other Trivia

Ok, if you're still reading then this probably isn't a big deal but I like to conclude with what it's all cost in terms of hard cash and time.

So, how long did I spend shut up in the workshop ?

Making templates for drilling discs & caliper brackets, probably no more than an hour in total. This was speeded up by cutting the centre out of an old Front Disc with a grinder, that really made a difference. So much so that if I did it again I'd be tempted to cut up a new disc !

Welding the brackets up, about 3 days. I don't work 8 hour days and I'm pretty slow with welding & cutting so if you said 15-16 hours from steel to painted bracket that would be about right.

In total I started on a Monday afternoon and had the car road testing Friday morning.

Materials :
2x Citroen BX front discs, £25.
2x BMW Mini Rear Discs, £28

Steel : Unequal angle steel 100mm x 50mm x 6mm x 500mm, Price: £9.05
Steel : Equal angle steel 50mm x 50mm x 6mm x 500mm, Price: £8.09

I retained the old brake pads for now, so overall a cheap project, £70 all in ?