Rear Spring Plate Angle Settings

Wil Ferch, March 26, 2000

I think I've got it. According to theory and my faith in math, at least.
I think I have a way to predict proper spring plate angle when setting up a car with OEM or larger torsion bars.

We first need to agree on some things. A while back, I posted equivalent spring *rates* vs rear torsion bar sizes, and it also included measurements I've taken on the spring plate length (18.5 inches...from TB centerline, to wheel centerline). We need these numbers , so for convenience, I will repeat them here:

torsion bar size (mm)	spring rate (lb/in)
23	100
24	120
24.1	122
25	140
26	165
27	191
28	221
29	254
30	291
31	332
32	377
33	427

We'll also assume that all torsion bar 911's use a spring plate as measured here (18.5"). Let's also repeat some things published by Porsche in their Tech books, and see if we can verify our assumptions against them:
- Porsche says that every 1 degree of spring plate angle is worth 8-9 mm in ride height (early tech books) , but they change that to 7-9 mm, in later tech books. Actually , this discrepency makes sense, since it varies by the severity of the angle. Let's use our "assumption" measurements and see how we stack up. Lets's try 2 cases...the first one going from 37 to 38 degrees angle....and the second case where we only go from 2 to 3 degrees angle...a much shallower proposition, but the same net change of one degree. Let's make life easier by pretending we're looking at the driver's side of the car (left side, or US spec for our English friends)...assuming "zero" degrees is a spring plate horizontal to the right, and normal "droop" would make the far right end drop "down". This would define a right triangle, with the spring plate as the longest length (hypotenuse), and the vertical droop defined as a function of the "sine" of the droop angle...basic trigonometry:

Case 1:
37 degrees down from horizontal.
vertical droop is... (sin 37 degrees)(18.5") = 11.1335"

38 degrees down from horizontal.
vertical droop is ...(sin 38 degrees)(18.5")= 11.38"

difference for 1 degree is about 0.25" , or 6-7 mm. Close, but no cigar, compared to the spec books.

Case 2:
Lat's look at a shallow angle , like when a car is nearer to "ride height"...

2 degrees down from horizontal
vertical droop is...(sin 2 degrees) (18.5) = 0.6456"

3 degrees down from horizontal
vertical droop is....(sin 3 degrees) (18.5)= 0.968215"

difference for one degree is about 0.32" , or 8.2 mm. Viola !
It center-punches Porsche's claim in the spec books !

This proves that Porsche had "near ride height" in mind when quoting these numbers, in other words, assuming very shallow angles or "droops" from horizontal, and it also verifies our 18.5" spring plate measurement, otherwise, the math wouldn't work ! Let's go on.

We also need accurate car weight and spring rates for this to work. Let's first take a typical 1974 911, weighing about 2400 lbs, using standard 23 mm rear torsion bars. From my earlier post, a 23 mm bar is about a 100 lb/in spring rate. Typical weight distribution is 40/60, so the rear weighs 1440 lbs...and *each* rear wheel carries 720 lbs. Spec book says free hanging droop is 36.5 to 37 degrees down from horizontal. Let's use 36.5 degrees:
find vertical droop....call this "x"
x = (sin 36.5 degrees) (18.5)= 11.0042255" droop.

As we put this car on the ground, the "droop" will be lessened due to the 720 lbs weight we are applying. The amount this droop gets "lessened", is based on the spring rate (100 lb/in for 23 mm bar). So......

720 lbs of weight, pressed against a 100 lb/in torsion bar, moves the droop back "up" by 7.2 inches. The "net" droop then becomes 11.004" - 7.2" = 3.804" droop , when the car is on ground. This is the "ride height" droop. The equivalent angle that represents 3.804" of droop , can be found from:

3.804" = (sin of angle) (18.5"). Solving for "angle" ....the angle equals 11.866 degrees.

Let's move on to a nice example I saw in the spec books. Porsche claims that the 85 Carrera (2760 lbs weight), 24.1 mm torsion bar , requires a free hanging "droop" of 35 degrees, yet the identical 1986 car with 25 mm torsion bar requires only 32 degrees. Let's see how our methods check against this:

1985 Car:
torsion bar....24.1 mm (122 lbs/in rate)
rear *individual* wheel weight of 840 lbs (assuming 40/60 split, 2760 total).

droop ("x") = (sin 35 degrees)(18.5)= 10.61"
put car on ground, apply 840 lbs.
840 lbs / 122 lbs per inch rate = 6.88" less droop

"net" droop is 10.61" -6.88"= 3.73" droop at ride height. This should be no surprise. Just like the 1974 example, if the suspension plate arm length is the same, ride height is determined solely by the resulting "ride height droop"...we shouldn't be surprised these are nearly the same. Let's see how the 1986 car stacks up. Seeing a pattern develop, we may expect that the free hanging droop is less (it is , ...at 32 degrees with the stiffer 25 mm bar)...and we may expect to see a similar "ride height droop". Let's see if it works out this way:

1986 car:
torsion bar ....is 25 mm (140 lb/in rate)
rear *individual* wheel weight is same...840 lbs

droop ("x") = (sin 32 degrees)(18.5)= 9.8"
put car on ground..apply 840 lbs
840 lbs / 140 lbs per inch rate = 6" less droop
"net" droop is 9.8"-6"= 3.8"....droop at ride height. (equiv angle is 11.85 degrees using similar method as 1985 case.) As before, the ride heights are nearly the same in all cases, as you would expect.

Now, here is the real question....How do you determine spring plate angles for "non-standard" (read "upgraded") applications???? Let's use the 1974 car again as an example, and upgrade it to 26 mm bars, from the original 23 mm bars:

1974 car, weighs 2400 lbs...
maintain ride height (with new springs)...3.804" ride height droop , or 11.866 degrees.

We realize that a 26 mm bar has an equivalent spring rate of 165 lb/in. Working backwards from the earlier examples, we want to "add" droop suitable for the car's weight and torsion bar size. So...we want to "add" 720 lbs of wheel weight, but this will work against a 26 mm bar (at 165 lb/in)...so we get:
720 lb / 165 lbs per inch = 4.3636", of added droop.
We'll add this calculated "droop" to the static ride height "droop", to get total free hanging droop:
4.3636" + 3.804" = 8.1676" droop.

Using trigonometery again, we get:
sin of "angle" = (8.1676 / 18.5) = 0.441491891
Solving for "angle", we get: 26.2 degrees. This is the free hanging angle of the new set-up using 26 mm bars.

We can conclude with this table:

Weight bar free-droop angle (vert drop) ride height angle (vert drop)

2760 24.1 35 deg (10.61") 11.63 deg (3.73")
2760 25 32 deg (9.8 ") 11.85 deg (3.8")

2400 23 36.5 deg (11.004") 11.866 deg (3.804")

2400 26 26.2 deg (8.1676") 11.866 deg (3.804")

From these examples, we can calculate any other combination. We need , however, vehicle weight, torsion bar equivalent spring rates, and a scientific calculator or trig tables.

Any caveats? Yes. We are working with very precise , and small measurements, so accuracy is of utmost importance. Rubber bushings that deflect or deteriorate, don't help. I also find other tech items that the Porsche spec books qoute ,as not jibing with these calculations. For example, in almost all our examples, the static ride height is about a 3.75"-3.8" droop, as measured from the centerline of the TB, to the centerline of the wheel. Porsche spec books use various numbers (USA vs Rest-of-World settings, etc)...but a typical number quoted is 12 mm, or about a 1/2 inch. Doesn't make any sense , and this would define a *very* shallow, nearly horizontal spring plate at ride height, and I just don't see many cars this way. Maybe they mean to measure from the *bottom* of the exposed torsion bar tube , ...????

Anyway, this won't be perfect, but it may allow you to use "trial and error" on paper first, and avoid doing this 4 or 5 times for real. Even if gets you close enough to do it over only two times, it would be worth it.

If this works, (anyone who tries it, let me know)...I only ask that from this point forward it be known as the "Ferch" method of suspension calculation....hell, we have Planck's constant, Avagodro's number, Googleplexes, etc...why not a "Ferch" constant ? :)

Hope it helps.....

Wil Ferch - 85 Carrera
WFerch6687@aol.com