BMW R1200GS Sidestand Analysis

1 Introduction

After purchasing my new BMW R1200GS motorcycle, I realized that the stock sidestand was a little short, which resulted in the bike leaning to the left a bit more than I like. Since I'm not too tall (5-8), when sitting astride it, it was a little difficult to push the bike up off of the sidestand.

I used an `app` on my iPhone to measure the angle of lean of the motorcycle, and found that it was 14°, as shown in the photograph of Figure 1.

Figure 1: Bike lean of 14° with original sidestand. This was a little too much for me.

I had recently purchased a sidestand "foot" which clamped onto the end of the sidestand—it gives the sidestand a greater area, to prevent it sinking into soft earth. I realized that with this sidestand foot, it would be possible to fabricate a "spacer" to place between the original sidestand and the tip, which would effectively lengthen the sidestand, and position the bike a little more upright.

The issue, of course, is: **how thick to make the spacer?** The "shadetree" mechanic would make one, try it, change it, try it again, and so forth. By the way, this process is called *iteration,* and is usually inevitable in mechanical design (actually, I could have put shims under the sidestand until I got the angle I wanted, then just measure them—but this is more fun).

But I thought to myself, "hey, you're a smart guy, and you've had all this math and engineering training, you ought to be able to analyze the geometry, and get it right the **first time**." No iteration necessary. I would like the bike to lean about 7°—half of the original.

2 Analysis

2.1 Original Triangle

This is purely a problem of **geometry**. Figure 2 shows the triangle formed by the kickstand, the bike, and the floor. The parameters in Figure 2 are:

a = bike from floor to stand pivot (unknown)
b = length of stand = 12 in
c = length across floor (unknown)
α = angle of stand = 62°
β = complement of bike angle from vertical = $90° - 14° = 76°$
γ = angle between bike and stand (unknown)

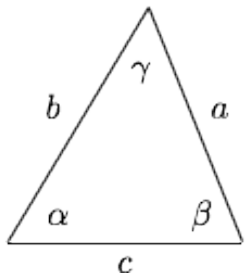

Figure 2: Triangle formed by bike, sidestand, and floor.

To continue the analysis, we need to find the unknown parameters of Figure 2. There are **two** tools that are used to analyze *oblique* (*i.e.* non-right) triangles:

- The *law of sines*
- The *law of cosines*

The law of sines is simpler than the law of sines, and fortunately that's the one we need to use here. The law of sines relates the sides of a triangle (a, b, or c), and the corresponding opposite angle (α, β, or γ). The law of sines is:

$$\frac{a}{\sin\alpha} = \frac{b}{\sin\beta} = \frac{c}{\sin\gamma} \tag{1}$$

However, we only know two angles of the triangle—angle γ is unknown. But that's no problem, since the three angles of a triangle *must* sum to 180°. Therefore,

$$\alpha + \beta + \gamma = 180^\circ \implies \gamma = 180^\circ - 76^\circ - 62^\circ = 42^\circ \tag{2}$$

Now we know all three angles, and can fully apply the law of sines.

To solve for side a we rearrange (1) to obtain

$$a = b\,\frac{\sin\alpha}{\sin\beta} = 10.91 \text{ in} \tag{3}$$

To solve for side c we do likewise:

$$c = b\,\frac{\sin\gamma}{\sin\beta} = 8.28 \text{ in} \tag{4}$$

Actually, I didn't need to analyze the "existing" triangle, but this is exactly the same approach I'll need to use for the "new" triangle (with the longer stand), so it was worthwhile to go through it.

2.2 New Triangle (longer Stand)

The task now is to see how much the sidestand must be lengthened to achieve a 7° lean angle of the bike. Considering the triangle of Figure 2, when the sidestand side is lengthened a will remain the same, but lengths b and c will increase. Likewise, angle γ remain the same, but angles α and β will change.

Since I want the bike to lean 7°, the "new" angle $\beta' = 90 - 7 = 83^\circ$. The "new" triangle is shown in Figure 3. The "prime" designation denotes the "new" parameters.

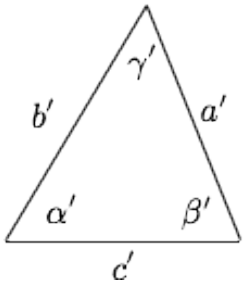

Figure 3: New triangle formed by bike, sidestand, and floor.

Since all three angles sum to 180°, we can find α' by

$$\alpha' = 180^\circ - \beta' - \gamma' = 180 - 83 - 42 = 55^\circ \tag{5}$$

The distance we want is new sidestand length b'. Using the law of sines,

$$b' = a'\,\frac{\sin\beta'}{\sin\alpha'} = 13.23 \text{ in} \tag{6}$$

Thus the sidestand must be **1.23 inches longer** than the original.

3 Fabrication and Installation

All this analysis and calculation is just the *prelude*—now we need to build the thing and see if it works...

3.1 Fabrication of Sidestand "Shim"

I was going to use a piece of Arkansas Black Walnut (the Queen of American hardwoods) for the shim, but I got lazy and used a piece of a Douglas Fir 2×4. It so happened that the longest machine screws I had permitted only a 1-inch shim.

I resawed it to thickness, then cut out the proper shape on the bandsaw, Before painting it black (it shows up better before painting), I snapped a photo, which is shown in Figure 4. After the photo, I removed it and painted it black, so it is actually not at all noticeable.

Figure 4: Unpainted 1-inch shim in place on sidestand.

3.2 Installation—Does it Work?

Well, a photo of the bike on the "modified" sidestand is shown below in Figure 5. By my measurements, the new "lean angle" is about 5°, which is a little less than my design specifications, but it works just fine.

I did all this in July, and have been using the modified sidestand for about 8,000 miles. It works perfectly, and is one of the best modifications I have made.

Figure 5: Bike lean of 5° with modified sidestand—perfect!