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Yamaha R1 Aluminum Girder Front Suspension from SuspensionSmith of Australia

by Paul Crowe - "The Kneeslider" on [10/17/2011](#)

in [Motorcycle Builders](#)



Yamaha R1 with aluminum girder front suspension from SuspensionSmith of Australia

Laurence Smith runs SuspensionSmith, a suspension business in Australia. Working on motorcycle forks, shocks and swingarms all day, it shouldn't be surprising he has a few of his own ideas about what comes between the wheels and frame and when he started thinking about why girder front suspensions weren't often found on sport bikes, he decided to look into it. Of course, Laurie was in a better position than most of us to work out answers to his questions and the result is the bike you see here, a 2004 Yamaha R1 with his very own aluminum girder front suspension. He's pretty pleased with the result and thought readers of The Kneeslider might want to have a look. Laurie sent me some photos and explained how it all came about.

Here's what Laurie had to say:

The project began in late 2009. I was wondering why girder forks aren't seen on any sports and race bikes,... usually just on very old stuff like Vincents, Ridges, etc. and on modern bikes it's usually restricted to custom bikes and cruisers, low dynamic performance stuff. Why is this so when girders have all the advantages of link type systems with antidive characteristics, low stiction etc.?

I began by using Tony Foale's FFE suspension software to investigate the working dynamics of how girders function. I then built a rough prototype to test some ideas on geometry and construction, the bike I used was an FZR400 frame with a 98 CBR 919 motor for extra go that I had built some time ago.



First girder prototype on FZR400 with Honda CBR 919 engine

This prototype taught me a lot of what I needed to know for the next step. Having mucked around with the FFE software I realized what the problem with girders was. The advantage a link type design offers is the ability to tailor the wheel path and control the amount of prodiver/antidive you want to use, which, in this case, means a more vertical wheel path. The girder's big weakness with this wheel path is massive trail loss when braking or when the suspension moves in general.

The reason is the wheel on a girder moves independently of the steering axis with a more vertical wheel path, this leads to an increase in steering offset which leads to trail loss and all the problems associated with very low trail.

On teleforks the wheel moves in parallel with the steering axis and offset is fixed and so doesn't change, so trail doesn't change except with variations in rake angle. Other designs like Hossack, center hub, etc., the steering axis moves with the wheel/suspension and again offset is fixed so trail remains more constant.

So how do I fix this? Very simply, steepen the rake angle so that the rake angle closely follows the wheel path and offset and trail remains more constant, it's not perfect but miles better than what has been before.

I chose a 16 degree steering rake angle and I was very confident of doing this because Tony Foale has long put forward the advantages of steep rake angles and these kinds of angles are commonplace in bicycles, from mountain bikes to road bikes, and to do this I needed to modify an existing frame to achieve this angle. I found the 04 R1 to be the best candidate for this type of modification, which was just a matter of cutting out the standard steering head and welding in a custom longer one.



Longer steering head welded on R1 Frame

With that done I now designed and made the link setup with rearwards offset link pivots, the advantage of this design is it allows the use of very long links but still keeps the design very compact for good steering clearances and a very low steering inertia. Another advantage is the natural balance the steering now has, a telescopic fork has most of its steered mass in front of the steering axis so its natural balance is to fall away from center, my girder fork has its steered mass behind the steering axis so its natural balance is to return to center and stay centered, that's gotta be good for stability and feel.

A very important feel, one of the biggest advantages of a telefork is the direct feel it gives to the rider and as riders that's what we are used to. My girder retains that kind of feel with benefits. So I did a first prototype in wood to test some ideas.



First R1 girder prototype in wood

Then made the final design in 6061 aluminium and a TTX30 front shock from a quad bike.



Final R1 girder design in 6061 aluminum

Wasn't long before the bike was ready for its first road test.



First road test of the R1 girder

Overall it feels brilliant, it has exceeded my expectations. The steering isn't twitchy or sensitive, its uber stable and ultra precise, the suspension works very well over very rough surfaces and braking is a revelation, I have dialed in some amount of initial brake dive but it is very controlled and confidence inspiring.



Yamaha R1 with aluminum girder front suspension

Thanks, Laurie. Well guys, that's how you do it. You get curious and then you get busy, you answer the "I wonder" with action. The Yamaha R1 seems to be a good candidate for this conversion, but there may be some other possibilities, too. How long before we see more of these? Great work Laurie.

Link: [SuspensionSmith](#)

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phil [October 17, 2011 at 11:53 am](#)

It's always nice to see expertise put to good use. The only 'problem' I see is that the rake gives the disconcerting appearance of having contacted a sturdy wall at speed. 😊

Great work though.

[Reply](#)

Paul Crowe - "The Kneeslider" [October 17, 2011 at 12:00 pm](#)

Lots of new and very effective technology can look odd when you first see it simply because you're not used to it. If all sportbikes used girders, "normal" forks like we use today might look like a stretched out chopper in comparison. It's all perception.

[Reply](#)

Ola [October 17, 2011 at 12:49 pm](#)

Very interesting, I love it when people do stuff that hasn't been tried before, just because they're curious, instead of rehashing the same old, conservative concepts!

It seems that unsprung weight would increase quite a bit with this design though, but maybe the difference between this aluminium structure might not be so big, compared to steel inner fork legs?

[Reply](#)

Viv Collins [October 17, 2011 at 12:53 pm](#)

Ok took me a few moments to realize exactly where the bottom link was located in relation to the top link on his final version and work out the angles and benefits.

I have to say my first reaction was to back away slowly while keeping an eye on it just in case it did some thing unexpected 😊

[Reply](#)

QrazyQat [October 17, 2011 at 1:21 pm](#)

"Lots of new and very effective technology can look odd when you first see it simply because you're not used to it. If all sportbikes used girders, "normal" forks like we use today might look like a stretched out chopper in comparison. It's all perception."

If you look at a standard older bike from when I started in the late 60s and a sport bike today, the rake is way out there.

Back when mag wheels just came to be on bikes, we put a set on a Honda belonging to the son of the shop's owner. It sat around for a week waiting for his buddy's identical Honda to show up to be shipped overseas with our race cars (they were going on a trip after Le Mans). When the other bike showed up those wire wheels looked so weird, so old fashioned. A week before they'd looked pretty normal to me. 😊

[Reply](#)

kim [October 17, 2011 at 2:34 pm](#)

While I'm sure this system works very well, and probably better than the bike's stock front end, he's up against two problems: The bying public's conservatism, and the fact that the tube type fork still seems to have development potential. BMW's introduction of the telelever didn't keep even that large

company from using traditional forks on their smaller bikes, or reverting to them on their really fast sports and race bikes.

As for the looks, I think there will still be some out there who find the more aggressive stance desirable – the prototype with the carbon fibre girder type front end from Confederate Motorcycles had a bit of that too.

[Reply](#)

Paul Crowe - "The Kneeslider" [October 17, 2011 at 3:12 pm](#)

You're right, we've talked before about the conservative nature of motorcycle buyers in general, but within that group is a smaller group who would be happy to try something like this on their own bike, it's not a mass market application. Once you ignore the idea that you have to sell a million of something to be successful, you can try a lot of new ideas that could work really well.

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B*A*M*F [October 17, 2011 at 2:40 pm](#)

This really makes me want to adapt the Hossack/Fior suspension to a bike of some kind. How cool is this?

[Reply](#)

Tin Man [October 17, 2011 at 3:13 pm](#)

I also find the look unpleasant, Its not just because its different, it just does not flow with the lines of a bike. There is such a thing as Beauty, The Hunan eye can detect beauty even when we can't describe beauty. Look at buildings from the 60s, they looked trendy at the time but have not aged well, then look at a nice Red Brick pillored building built 100 or 300 years ago, still looks "right", good taste never goes out of style. This concept holds true for Fashion (Narue Jacket) , Auto design (Aztec) or of course Motorcycles.

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GM [October 17, 2011 at 4:29 pm](#)

Totally agree with you. But give this version some slack, it is mostly a proof of concept. Any version of this suspension that makes it to production is likely to have its aesthetics refined. Especially if the bike is designed from the beginning with this in mind.

[Reply](#)

Claymore [October 17, 2011 at 3:52 pm](#)

With the weight balanced closer to the center of the wheel, it just seems like it would be more prone to 'catch' on a pothole or something.

[Reply](#)

hoyt [October 17, 2011 at 4:50 pm](#)

Cool project & great execution. It's nice to see someone in the business of suspension systems trying

alternatives.

Aesthetically, you probably have to see it in person before commenting negatively. The vertical appearance would be offset by the shock's angle if you run it naked

Isn't the unsprung weight on this design only from the bottom "scissor" pivot point down?

[Reply](#)

Ola [October 17, 2011 at 6:01 pm](#)

The unsprung weight would be at least the entire "fork leg" structure, and possibly also parts of the pivot arms, since all that would be moving as unit. I'm guessing also the bottom end of the shock, no?

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Rob [October 17, 2011 at 6:34 pm](#)

Paint that girder in one or both of the two tones of grey like the bike and Bob's your uncle. It's just a bit shiny compared to the rest of the bike. Maybe some plastic on the girder to make it look more aerodynamic and incorporate a front mud guard.

[Reply](#)

BoxerFanatic [October 17, 2011 at 6:50 pm](#)

This few tells me very little other than rake is pretty steep, and trail is probably near zero.

But without seeing the acting members of the suspension, which are likely behind the fairing, it is hard to actually evaluate.

most previous "girder" suspensions have not solved the dis-association of the suspension forces from the braking forces.

Hossack/Fior/Duolever does that.

RADD also does, with a lower center of gravity, but more complexity.

I am not sure if this one does, or if it is just a steered damper atop some rigid legs.

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BoxerFanatic [October 17, 2011 at 6:51 pm](#)

Web page didn't load the additional pics until after I refreshed... now I see the additional photos.

[Reply](#)

Mike [October 17, 2011 at 7:14 pm](#)

... or maybe a full carbon fibre confection like the Confederate Motorcycles B120 Wraith?

[Reply](#)

Rich [October 17, 2011 at 8:10 pm](#)

I am rather certain the trail is of a conventional nature. If you visit Tony Foale's website you can read his tests of unconventional rake angles and the bikes actually have positive handling attributes as a result. Trail can be at conventinal numbers by changing offset.

I would have done a Hossack as opposed to a girder to reduce steered inertia but it is a beautiful bit of work.

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So, what do YOU think?

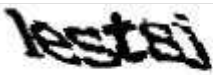
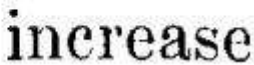
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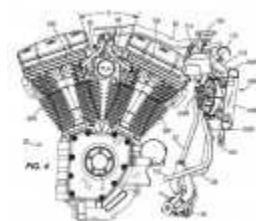
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