[MC-CHASSIS-DESIGN] The Correct Amount of Front Anti-Dive?

45 messages

jac.brown@2020comm.net <jac.brown@2020comm.net> Mon, Jan 26, 2015 at 4:15 PM
Reply-To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>
To: mc-chassis-design@micapeak.com

This may be a double posting. Sorry if I screwed it up. I made the mistake of attaching photos and Mr. Moore was kind enough to post the photos on his web site. Thanks, Michael.

First, let me share a little project that I first ran across about 3 years ago. The bike in the photos was built by Martin Snuvsnuverink (I hope I spelled that correctly) and he was very kind in explaining the project and discussing what he learned. Please follow the address below to the photos that Michael has hosted for me.

http://www.eurospares.com/graphics/chassis/MartinVTRHondaHossack/

This is all from memory, so I may have some of the information mixed up. Even if I screw up some of the information, it is a nice project. The bike started life as a Honda VTR 1000 Super Hawk. Martin put it together with his own frame, a Hossack front end of his design, and RC51 fairing and radiators. He wasn't sure what the correct geometry should be, so he built it so that he could vary the anti-dive and the rake/trail. If you look at the close up picture of the front suspension, you will see that he can adjust the height of the upper A arm on the fork and that he has eccentric mounting discs for the upper A arm on the frame. By using different mounting discs in different orientations, combined with the adjustable fork attachment, he can vary the anti-dive and rake/trail over a fairly large range.

Apparently, he did a fair bit of experimentation and finally chose an estimated 40% anti-dive.

So the questions to this group are: What is the correct target range for anti-dive in a front suspension design for road use? Is 40% a good target? What are the factors for deciding? What are the trade-offs?

I have read Tony's excellent book and it gives some rough guidance. I

have also read Cossalter's book and it gives a few more ideas.

At the moment, here are the factors that I am tracking. Am I missing something?

1. Too much forward motion of the contact patch on bump (high anti-dive) results in harsh ride
2. Brake dive is a signal to the rider for how hard he is braking. Less dive can be good, but too little dive means poor feedback
3. Suspension pitching during brake dive result in a shorter trail which make the handling more responsive. An experienced rider takes advantage of this. What ever the brake dive, the trail change in braking and cornering should be smoothly changing and predictable. Probably, short trail in braking is better.

Thanks in advance.

Jac

Sebastian Wiers <sebwiers@gmail.com> Tue, Jan 27, 2015 at 1:05 PM
Reply-To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>
To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>

> Apparently, he did a fair bit of experimentation and finally chose an
> estimated 40% anti-dive.

Much like the builder of that bike, I'm currently putting a FFE front on an old bike. My design actually very closely matches (in concept and even some details of execution) the one Claude Fior patented in 1983, seemingly as a case of parallel evolution since I looked only at Hossack's (and similar) stuff for a long time, and then a few days ago saw the Fior's patent after I'd hammered out my shock location etc.

I was originally shooting for 100% anti-dive (as specified in Tony's FFE program) but wound up with my pivot locations ~100mm further forward than originally planned (made mounting much easier, and helped avoid the arms hitting things). This made my wheelbase over 1500mm and gave a silly amount of space between the front wheel and engine, so I went with shorter arms (225mm lower vs my originally planned 325mm, with similar change for the upper), resulting in 50% anti dive for the first half of travel, ramping up to 100% at full compression. I expect this to be quite nice for my non-sporting purposes, but honestly have no idea just what it will be like. That's why I'm building it, to find out!

> So the questions to this group are:
> What is the correct target range
> for anti-dive in a front suspension design for road use? Is 40% a
> good target?

My guess is anything that doesn't vary wildly (Ie, stays in a range of +/- 30% from some central value) and doesn't go far above 100% (max central vlaue of 100%) is OK, with 'ideal' just being a matter of rider preference & expectations. I think the reports are that riders used to telescopic style front ends often complain about 'lack of road feel' when kinematic anti-dive gets above 50% or so. Because I specifically want to see how anti-dive affects my daily riding experience, I'm going for a bit more, and designed my setup so that increasing anti dive is an easy adjustment to make.

> What are the factors for deciding? What are the
> trade-offs?

In my case the decision was arbitrary, and based on wanting an easily observed change in 'feel' (I have two of the same bike, one will be un-modified). The trade off ended up being packaging; higher anti dive (that didn't spike far past 100%) would have required a construction that was best suited to a custom frame, not the modification I was doing.

> 1. Too much forward motion of the contact patch on bump (high
> anti-dive) results in harsh ride

I don't know about that. My ride will probably suck anyhow, regardless of suspension type (wheels for that bike are noted as being awful heavy, nor does my construction help that.) I did shoot for a design that stayed under 100%, but will likely experiment with increasing it to 150% or so, just so see the effect.

> 2. Brake dive is a signal to the rider for how hard he is braking.
> Less dive can be good, but too little dive means poor feedback

That's the complaint I've heard supposedly reported in racing use. My personal experience is that the braking feedback on my rigid forked 26" bicycle with hydraulic front brakes is fantastic for commuting use (I once completed a left turn entirely on my front wheel while avoiding an oncoming vehicle, and on a smooth surface can take the wheel to the edge of lock-up and back at will). I'd expect for optimal feedback I want my suspension to NOT be affected by braking, as much as possible.

> 3. Suspension pitching during brake dive result in a shorter trail
> which make the handling more responsive. An experienced rider takes
> advantage of this. What ever the brake dive, the trail change in
> braking and cornering should be smoothly changing and predictable.
> Probably, short trail in braking is better.

That sounds like post-hoc justification to me. If I can set my bike up to have 18 degree rake and 90mm trail across the entire range of front bump (roughly what I'm shooting for), won't it be just as responsive under braking as one that only typically reaches that when the travel is eaten up by brake dive forces (making the suspension stiff and unresponsive)? That was my thinking, and exactly what I was building to experience for myself.

-Seb

Mark Mattock <mattock@telus.net> Tue, Jan 27, 2015 at 1:32 PM
Reply-To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>
To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>

> resulting in 50% anti dive for the first half of travel, ramping up to 100% at full compression.

100% anti-dive = no suspension compression due to weight transfer or braking forces? I would think that will feel really harsh and numb, but can't say from personal experience. I do recall seeing:

1) Comments somewhere that formula cars in the past seldom used more than about 50% anti-dive because the drivers complained of harshness above that.
2) Patrick Head commenting years ago that they never tuned out all the body roll even when using active suspension because the drivers didn't like it. His thought was that the drivers were using the roll (as minimal as it is on an F1 car) as a feedback source on cornering forces.

In my doodling and tinkering with both FFE's and LLF's I have always aimed to have ~0% anti dive at full droop moving to moderate amounts of anti-dive (15-20% or so) at full bump. I look forward to hearing how your experiment with very high levels of anti-dive work out.

Mark

Alan R. Lapp <alanlapp@levelfive.com> Tue, Jan 27, 2015 at 3:24 PM
Reply-To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>
To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>

Two thoughts –

On Jan 27, 2015, at 1:32 PM, Mark Mattock wrote:

> 1I would think that will feel really harsh and numb, but can't say from personal experience.

100% anti-dive leaves the suspension available and functional to absorb bumps, whereas pro-dive suspension consumes travel under braking.

As we know, on standard tube-fork suspension, braking bumps when hard on the brakes can produce some anxiety. Anti-dive should at the very least eliminate the fear of bottoming out while hard on the brakes. Been there, done that, can't recommend it.

>
> 1) Comments somewhere that formula cars in the past seldom used more than about 50% anti-dive because the drivers complained of harshness above that.
> 2) Patrick Head commenting years ago that they never tuned out all the body roll even when using active suspension because the drivers didn't like it. His thought was that the drivers were using the roll (as minimal as it is on an F1 car) as a feedback source on cornering forces.

In my experience, roll also softens and broadens the point at which the tires slide.

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I'm never really comfortable—or completely awake—around people
who are unacquainted with the invigorating joys of mild panic.

Peter Egan
––––––

Sebastian Wiers <sebwiers@gmail.com> Tue, Jan 27, 2015 at 4:27 PM
Reply-To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>
To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>

>> resulting in 50% anti dive for the first half of travel, ramping up to 100% at full compression.
>
> 100% anti-dive = no suspension compression due to weight transfer or braking forces?

100% as in that's what Tony's FFE program says on the graph for
anti-dive. I can't say precisely what that means in real world terms.

But yes, I think it means the anti-dive forces 100% cancel the
expected brake & weight transfer (maybe also factoring in some other
effects like rotational wheel inertia), so that there is no tendency

to pitch forward. I think anti-dive over 100% would result in converting a portion of braking forces into suspension EXTENSION, which seems like it might even be useful at full bump. Part of the point of building it is to maybe find out what those numbers mean in subjective terms. (The other part is just to have fun building, and make something that looks cool.)

> I would think that will feel really harsh and numb, but can't say from personal experience.

By the time suspension reaches full bump, I'd think it would already feel pretty harsh. Especially given midwestern road conditions. I'm not gonna be bottoming it out due to crazy lean angles; potholes are the bigger concern. ;)
My expectation would be it would feel like you are stopping without pitching any, with the suspension still soaking up bumps more or less as if you were not braking, Sounds good to me. If I find it is harsh, that's some good info to learn, and its not impossible to dial it back.

> I do recall seeing:
>
> 1) Comments somewhere that formula cars in the past seldom used more than about 50% anti-dive because the drivers complained of harshness above that.

How is anti-dive achieved there? Is the '50%' they are using the same as the 50% in Tony's program?

> 2) Patrick Head commenting years ago that they never tuned out all the body roll even when using active suspension because the drivers didn't like it. His thought was that the drivers were using the roll (as minimal as it is on an F1 car) as a feedback source on cornering forces.
>
> In my doodling and tinkering with both FFE's and LLF's I have always aimed to have ~0% anti dive at full droop moving to moderate amounts of anti-dive (15-20% or so) at full bump.

Those 0-20 figures (according to the program) are actually rather easy to accomplish with the build I have. I'd just need to put 15mm worth of spacer under the lower ball joint, a 10 minute job at worst. Its about 5% decrease in anti dive per mm of spacer, so I'll be sure to try a variety of settings. In fact, I doubt I'll ever be able to measure the EXACT distances, and given that a few mm make a big difference to the anti-dive numbers, I'll pretty much have to tune it to personal feel, and never be able to say "yeah, that feels right because it is exactly X%".

This was a happy accident of construction but I highly suggest it as a design feature because it seems quite easy to include. That is, it seems that on a Hossack setup, having the option to move the lower 'ball joint (pivot on the upright) so as to change where it sits between the wheel and upper pivot, makers it possible to have a large latitude in tuning the anti-dive strength, and simply bolting a ball joint to a bridge makes that pretty easy to manage (although its probably not the lightest of construction methods).

> I look forward to hearing how your experiment with very high levels of anti-dive work out.

There's a ways to go before it's ridable ((or even can be tested for safety), and its quite possible I've mis-interpreted the whole concept. Either way I'm probably not qualified to give an objective analysis, so unless there's something amazing that happens (like I'm suddenly transformed into a skilled stunt rider, gliding over potholes while doing stoppies) it will be pretty much 'yup, its ride-able' or 'nope, I can't stand it'.

-Seb

Rick Hammond <r.hammond@sympatico.ca> Tue, Jan 27, 2015 at 4:48 PM
Reply-To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>
To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>

The first I remember was the BMW setup with the brake caliper on a 'floating' arm going back to a rod taking the braking force up to the frame.
Would that automatically be 100%? Would a shorter arm be less than that?
Cheers,
Rick
[Quoted text hidden]
—
"Which way you headed, Jeremiah?" (Johnson)
"Canada, maybe. I hear there is land there a man has never seen."

Mark Mattock <mattock@telus.net> Tue, Jan 27, 2015 at 5:04 PM
Reply-To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>
To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>

> How is anti-dive achieved there? Is the '50%' they are using the same as the 50% in Tony's program?

In the same fashion as the Hossack and other FFE's, with the geometry of the suspension components balancing forces. Yes, the 50% is the same where 50% anti dive means 50% of the suspension compression is eliminated.

> Either way I'm probably not qualified to give an objective analysis, so unless there's something amazing that happens (like I'm suddenly transformed into a > skilled stunt rider, gliding over potholes while doing stoppies) it will be pretty much 'yup, its ride-able' or 'nope, I can't stand it'.

You might be surprised what feedback you can offer once you get some time on it, never give up hope.

Mark

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jac.brown@2020comm.net <jac.brown@2020comm.net> Tue, Jan 27, 2015 at 5:51 PM
Reply-To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>
To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>

On 2015-01-27 19:27, Sebastian Wiers wrote:

> > resulting in 50% anti dive for the first half of travel, ramping up to 100% at full compression.
>
> I think anti-dive over 100% would result in converting a portion of braking forces into suspension EXTENSION, which seems like it might even be useful at full bump. Part of the point of building it is to maybe find out what those numbers mean in subjective terms. (The other part is just to have fun building, and make something that looks cool.)

Regarding the Honda that I referred to in the opening post, the builder, Martin, said that he had tried anti-dive of greater than 100%. He said that the front end rising during braking felt very strange. You could brake very hard with confidence but you didn't have confidence about the lock up feel at the limit. As I mentioned earlier, he ended up with about 40% as a nice balance.

Sebastian,

You have a very interesting project there and you are far ahead of me. I'm just at the paper study stage. I look forward to your observations, in particular because you are not trying to build a race bike, but one for everyday riding. Keep going.

> I would think that will feel really harsh and numb, but can't say from personal experience.

I can't say from motorcycle experience, but from the car side, I can tell you that small changes in anti-dive, even when anti-dive is near zero, cause big changes in ride harshness. My opinion is that forcing the unsprung mass forward results in higher accelerations to the driver/rider and when the tire has to both step up and forward, it must deflect more to envelope a given bump. Both of these are bad for harshness.

> I do recall seeing:

> 2) Patrick Head commenting years ago that they never tuned out all the body roll even when using active suspension because the drivers didn't like it. His thought was that the drivers were using the roll (as minimal as it is on an F1 car) as a feedback source on cornering forces.

I once had an interview with the head of active suspension on the Formula 1 cars at Lotus. He said that they originally programmed out all of the roll and dive and used the actuators to balance the handling. Senna himself was doing the test driving and he hated the car and went slower than in the passive car. Apparently, the drivers were used to certain responses from the car and used them to "trick" the car into doing what they wanted. When those responses were unavailable, they didn't like it. In the end, they put some roll and dive back into the car for the driver's "feel".

Michael Moore <mmoore@eurospares.com> Tue, Jan 27, 2015 at 6:39 PM
To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>

> Martin, said that he had tried anti-dive of greater than 100%. He said that
> the front end rising during braking felt very strange.

You get the same effect with a BMW, Sachs/DKW etc LLF where the brake stay is tied to the link instead of the upright.

Rick, varying the length of the arm on the telefork antidive varies the leverage and the amount of a-dive, which is why the Spondon dual-arm version I copied was adjustable (though I never adjusted it on my Ducati)

http://www.eurospares.com/graphics/Ducati/ducati750GTBW001a2.jpg

In his book Tony discusses the benefits of a rearward path on the wheel (front or rear) for reacting to bumps.

> some roll and dive back into the car for the driver's "feel".

Tuning the driver/rider is probably the first thing that should be attempted before making changes to the vehicle.

cheers,
Michael

Mark Mattock <mattock@telus.net> Tue, Jan 27, 2015 at 7:07 PM
Reply-To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>
To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>

> The first I remember was the BMW setup with the brake caliper on a 'floating' arm going back to a rod taking the braking force up to the frame.
> Would that automatically be 100%? Would a shorter arm be less than that?

Nope. It varies according to rake angle, lever length and the pushrod geometry running up to the frame mount and possibly some more things I didn't think of off the top of my head.

Mark

Laurence Smith <suspensionsmith@gmail.com> Wed, Jan 28, 2015 at 1:32 AM
Reply-To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>
To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>

I have been track testing a Hossacked 2010 honda fireblade recently and my experience so far is showing me in regards to the balance between wheelrate and antidive is to run a high wheelrate and low antidive percentage.....a high wheelrate on a racebike alone does a very good job of limiting front brakedive and this in turn equally does a good job in supporting the front of the bike under high cornering forces for example.....the key is to have a very linear or low rate of progression so the wheel rate does not become to high further in the stroke. This of course means some brake dive but not anywhere near what a telefork gives and this dive should give beneficial changes in steering geometry somewhat the same as a telefork...I think if theres one thing teleforks do very well is steer.....so the key here I beleive is to not stray to far from the kinds of geometry characteristics a telefork gives...the main thing being to remove the prodive that teleforks give.

I recently did some brake tests with some data logging of lean angle/speed and braking G force and GPS positioning on track and some gopro footage to which I give a link to http://youtu.be/LU3620Le02c
The Vid first shows normal straight line braking where I saw a peak braking G force of 1.03G before the rear lifts and becomes unsettled.....then onto the straight and down into the entry into turn one which is fairly fast where you tip in still on full throttle and then roll off and smoothly onto the brakes whilst leaning the bike into the apex of the corner..
The data here shows a peak speed of 220kph as I roll off into turn 1....then a peak braking G force of 1.03G at a lean angle of 34 degrees and speed of 193kph.
The bike is very stable and feels like it has more to give.
Max suspension travel used during this footage is 87mm with a rider sag figure of 35mm and at this point of travel the prodive/antidive percentage as shown in tonys FFE analysis software is 7 percent ....I am using a maximum of 7 percent of antidive to acheive this figure of travel which by the way also includes cornering forces as well as braking force and weight transfer.

On another lap I acheived a peak breaking force of 1.16G at lean of 30
degrees and again the bike felt fine.
So again you dont need much antidive once you have removed the prodive of
a telefork in a FFE....wheelrate can do a pretty good job by itself....or
so it seems.
[Quoted text hidden]

Don Ricciardiello <don.ricci@me.com> Wed, Jan 28, 2015 at 4:10 AM
Reply-To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>
To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>

Laurie,

What do you mean by wheel rate?

Rgds,

Don

> On 28 Jan 2015, at 8:32 pm, Laurence Smith <suspensionsmith@gmail.com> wrote:
>
> I have been track testing a Hossacked 2010 honda fireblade recently and
> my experience so far is showing me in regards to the balance between
> wheelrate and antidive is to run a high wheelrate and low antidive
> percentage.....a high wheelrate on a racebike alone does a very good job
> of limiting front brakedive.

Alan R. Lapp <alanlapp@levelfive.com> Wed, Jan 28, 2015 at 10:26 AM
Reply-To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>
To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>

Very impressive!!

Thanks for sharing the video.

a

On Jan 28, 2015, at 1:32 AM, Laurence Smith wrote:

> On another lap I acheived a peak breaking force of 1.16G at lean of 30
> degrees and again the bike felt fine.

[Quoted text hidden]

Alan R. Lapp <alanlapp@levelfive.com> Wed, Jan 28, 2015 at 10:26 AM
Reply-To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>
To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>

Spring rate.

a

On Jan 28, 2015, at 4:10 AM, Don Ricciardiello wrote:

> What do you mean by wheel rate?

[Quoted text hidden]

Rick Hammond <r.hammond@sympatico.ca> Wed, Jan 28, 2015 at 10:45 AM
Reply-To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>
To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>

I looked around but couldn't find a reference,
Does anybody know what percentage of anti-dive the BMW Duolever (Hossack) has?
These are heavy sport tourers; 62 inch WB, 29+deg rake.. 4.1 inch trail..
http://www.topspeed.com/motorcycles/motorcycle-reviews/bmw/2014-bmw-k-1300-s-ar160449.html#main
Anyways, wondering if they have released or if anyone has measured the anti-dive.

I am using a front end off one of these for an F800 BMW twin.. May end up using part of the upper frame to locate the pivots but don't picture that much rake.. Have to figure out the effects if I steepen the whole assembly, but in any case I am still a fan of trail, so that will be a consideration too.
http://www.desmo.ca/pb/wp_c187c988/wp_c187c988.html
Oh yeah, apparently a recent change is the bottom 'a-arm' in aluminum instead of the forged steel. They describe it as a weight saving of 2.1 lbs, but describe it as 'un-sprung weight'.. I'm guessing they mean the total weight, of which only part would be un-sprung.. Not too worried; I'm ok with stock parts knowing they are engineered for commercial sales.. I'll take a bit of a weight penalty for peace of mind. (till I find an alloy part used ;-)
Cheers,
Rick
[Quoted text hidden]
[Quoted text hidden]

Michael Moore <mmoore@eurospares.com> Wed, Jan 28, 2015 at 11:45 AM
To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>

Alan, spring rate will vary from the wheel rate depending on how
leveraged the spring is. You could have the same wheel rate for
spring rates of 20-200 lbf/in.

cheers,
Michael

Laurence Smith <suspensionsmith@gmail.com> Wed, Jan 28, 2015 at 12:05 PM
Reply-To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>
To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>

Yeah wheel rate is spring rate measured at the wheel....so it takes into account all the variations that a particular suspension design can have on spring rate....wheel path,shock angles.linkages etc....and makes comparison between designs or changes easier

Laurie

On Thu, Jan 29, 2015 at 6:45 AM, Michael Moore <mmoore@eurospares.com> wrote:
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Laurence Smith <suspensionsmith@gmail.com> Wed, Jan 28, 2015 at 12:42 PM
Reply-To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>
To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>

I have also done some work on improving the Telelever....in particular a BMW R1200R for a customer.
The suspension isnt particularly good and like most telelever steering and handling could be better.
I couldnt model the Telelever using Tonys exellent FFE analysis but found another which will model a Macpherson strut which is basicly what a telelever is.
As most here probably know the bmw telelever is high in antidive as the wheel moves forward as it moves....the wheelbase gets longer.
I found by relocating the lower ball joint and turning it through 180 degrees so its now upside down ....this would raise the pivot centre of the ball joint in relation to the lower arms main pivot.
I also moved the balljoint back effectivly shortening the lower arm and also dragging back the telelevers wheel and two uprights,thus shortening the wheebase and putting more weight bias on the front,
I also revalved and resprung front and rear shocks to suit.
The upshot of this moved balljoint is a new wheel path which now moves slightly rearwards with the wheelbase now getting shorter and much reduced antidive.
The result is a transformaion of a bike which has much improved ride quality and significantly improved steering agility and handling which has a major effect on rider confidence and enjoyment.

Heres a vid of some track testing we did....the main limitation found now was the cylinder heads touching down which can be heard in some corners.....oh and the crappy gearbox action didnt help either.
http://youtu.be/rjB3eIKFN3A

On Thu, Jan 29, 2015 at 7:05 AM, Laurence Smith <suspensionsmith@gmail.com> wrote:
[Quoted text hidden]

Laurence Smith <suspensionsmith@gmail.com> Wed, Jan 28, 2015 at 1:38 PM
Reply-To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>
To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>

Rick I have modeled the K1300 duolever and I think its usefully accurate.
As shown in Tonys FFE analysis.
It starts off at around zero percent and over a travel of 120mm finishes at around 160 percent antidive.
Due to the wheelpath it has,the wheel rate is increasingly digressive after a wheel travel of 33mm...hence the strong antidive to counter it maybe.

On Thu, Jan 29, 2015 at 7:42 AM, Laurence Smith <suspensionsmith@gmail.com>
[Quoted text hidden]

Michael Moore <mmoore@eurospares.com> Wed, Jan 28, 2015 at 1:41 PM
To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>

Laurie, I bet it would help if you get get the BMW front wheel to always rotate in the proper direction!

Laurence Smith <suspensionsmith@gmail.com> Wed, Jan 28, 2015 at 1:53 PM
Reply-To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>
To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>

Yes that was an exciting missed downchange....saved by the antilock brake system I reckon.

On Thu, Jan 29, 2015 at 8:41 AM, Michael Moore <mmoore@eurospares.com> wrote:
[Quoted text hidden]

Don Ricciardiello <don.ricci@me.com> Wed, Jan 28, 2015 at 2:21 PM
Reply-To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>

To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>

So, once more for the dummies, assuming wheel movement and spring movement was one to one, then a high wheel rate is a soft spring and vice versa?

Rgds,

Don

[Quoted text hidden]

Laurence Smith <suspensionsmith@gmail.com> Wed, Jan 28, 2015 at 2:49 PM
Reply-To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>
To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>

Where wheel movement and spring movement are one to one then wheel rate will be the same as spring rate.

[Quoted text hidden]

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jannelder@aol.com <jannelder@aol.com> Wed, Jan 28, 2015 at 9:43 AM
Reply-To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>
To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>

No, high wheel rate means high stiffness of spring, (or high force per unit of displacement) .
–––––––––

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Laurence Smith <suspensionsmith@gmail.com> Wed, Jan 28, 2015 at 3:07 PM
Reply-To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>
To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>

Spring rate is measured by N/mm for example....wheel rate is then also measured as N/mm,so you are measuring spring rate at the wheel instead of at the spring.
By doing this you are taking into account all the variables that exist between the wheel and the spring which effect the motion ratio or leverage ratio.

On Thu, Jan 29, 2015 at 9:49 AM, Laurence Smith <suspensionsmith@gmail.com> wrote:

[Quoted text hidden]

Don Ricciardiello <don.ricci@me.com> Wed, Jan 28, 2015 at 3:12 PM

Reply-To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>
To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>

Got it, thanks. Just wanted to be clear about high wheel rate not meaning high velocity.

Rgds,

Don
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Bernard Geldenhuis <bernardgldnhs@gmail.com> Wed, Jan 28, 2015 at 3:14 PM
Reply-To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>
To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>

Just a quick one, wheel rate, is this vertical force on the line of the
contact patch, or along the direction of the wheel movement. the easiest
for me to visualize is a telescopic front end.

Thanks
Bernard

On Thu, Jan 29, 2015 at 9:07 AM, Laurence Smith <suspensionsmith@gmail.com>
[Quoted text hidden]

Don Ricciardiello <don.ricci@me.com> Wed, Jan 28, 2015 at 3:15 PM
Reply-To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>
To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>

Thanks Laurie.

Rgds,

Don
[Quoted text hidden]

Don Ricciardiello <don.ricci@me.com> Wed, Jan 28, 2015 at 3:27 PM
Reply-To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>
To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>

So how did the bike use the front tyre? I recall you discussing issues around getting heat into tyres of FFE bikes.

Rgds,

Don

> On 28 Jan 2015, at 8:32 pm, Laurence Smith <suspensionsmith@gmail.com> wrote:
>

[Quoted text hidden]

Michael Moore <mmoore@eurospares.com> Wed, Jan 28, 2015 at 6:21 PM
To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>

Laurie, I was referring to the effect (strobscopic?) where every 3-5 seconds the BMW front wheel stops and/or reverses rotation momentarily. I guess the delivery was too deadpan . . .

cheers,
Michael

Jeff Williams <jeff@cnerds.net> Wed, Jan 28, 2015 at 7:00 PM
Reply-To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>
To: mc-chassis-design@micapeak.com

I got it! I noticed the same and found I started just staring at the front wheel without registering anything else about the video.

Jeff

[Quoted text hidden]

Mark Mattock <mattock@telus.net> Wed, Jan 28, 2015 at 7:43 PM
Reply-To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>
To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>

> Very impressive!!

I agree, those numbers sound like something I would have to aspire to. I am pretty sure I have never braked at 1g on a track or anywhere else and certainly not combined with 30+ degrees of lean angle.

Mark

Mark Mattock <mattock@telus.net> Wed, Jan 28, 2015 at 7:45 PM
Reply-To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>
To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>

> I have been track testing a Hossacked 2010 honda fireblade recently

I forgot to ask if there were any pictures of this beast, I am curious how the conversion looks on a pretty current sport bike.

Mark

Laurence Smith <suspensionsmith@gmail.com> Wed, Jan 28, 2015 at 9:42 PM
Reply-To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>
To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>

The conversion is reasonably neat and not a huge amount of work....the
blade frame lends itself to this easily especially with the inlet ducts
being where they are....something like a current ZX10 kawasaki not so easy
wih its through steering head duct. The stock shape body work fits with
very minor mods and a custom Radiator is needed.
I took some design inspiration from Chris Cosentinos current moto2
project....
Heres some pics.....best thing about it is it seems to work very well,no
issues to date.

http://s193.photobucket.com/user/suspensionsmith/library/Hossack%20blade?sort=3&page=1
[Quoted text hidden]

Don Ricciardiello <don.ricci@me.com> Wed, Jan 28, 2015 at 10:01 PM
Reply-To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>
To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>

Very neat. Any issues with welding the die cast frame?

Rgds,

Don
[Quoted text hidden]

Brett Longhurst <brett@bremarauto.com> Wed, Jan 28, 2015 at 10:29 PM
Reply-To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>
To: mc-chassis-design@micapeak.com

Hi guys,

I've been reading this thread with a lot of interest... I'm currently building a VTR1000F with a girder front end myself. I've used Tony's FFE software for the initial geometry work, and also some more advanced multibody dynamics software for some other geometry and load calculations (this kind of simulation is my day to day business).

I've ended up with an anti dive adjustment range from almost fork like settings with about 100% prodive, through to around 30% antidive, although after reading this thread, I'm trying to build more antidive in at the moment just to see how it feels. I've got the wishbones fabricated and have just got all the bits together to start welding up the girder sides, so I'm going to have to decide soon!

This is all about learning for me as well, so it's great to hear of others doing a similar thing and sharing their knowledge...

Cheers, Brett.

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jac.brown@2020comm.net <jac.brown@2020comm.net> Thu, Jan 29, 2015 at 7:23 PM
Reply-To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>
To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>

Alas, work has taken me away from my email for a few days, so I'm just catching up.

I want to thank all of you who responded, especially Laurie with both of his bikes. Personally, I've come away from the discussion with several new ideas and some big concepts to think about. I am certainly more open to anti-dive in the zero to 20% range than I was thinking before this discussion. I also think that, as important as anti-dive is to an alternative front end, I will place a higher priority on change in trail and things that affect steering feel.

Laurie,

Both the Blade and the R bike are totally cool. I was amazed to see the front suspension travel on the Blade as you went around the rather bumpy track. I guess this stuff is hidden inside the forks in a "normal" suspension and we don't really understand how much work the suspension is doing.

Just curious, did you also shorten the wheelbase and get some additional front end weight when you Hossacked the Blade?

Jac

On 2015-01-29 00:42, Laurence Smith wrote:

> The conversion is reasonably neat and not a huge amount of work....the blade frame lends itself to this easily

> Heres some pics.....best thing about it is it seems to work very well,no issues to date.
>
> http://s193.photobucket.com/user/suspensionsmith/library/Hossack%20blade?sort=3&page=1
>
> On Thu, Jan 29, 2015 at 2:45 PM, Mark Mattock <mattock@telus.net> wrote:
>
> > > I have been track testing a Hossacked 2010 honda fireblade recently
> >
> > I forgot to ask if there were any pictures of this beast, I am curious how the conversion looks on a pretty current sport bike.
> >
> > Mark

Laurence Smith <suspensionsmith@gmail.com> Thu, Jan 29, 2015 at 10:23 PM
Reply-To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>
To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>

Cheers for the thanks Jac.
Having a point of reference for a starting point in FFE geometry and Kinematics can be tough when designing and building your first FFE.....theres so much to consider....its all about compromise and finding the best compromise to suit your app.
The front wheel at full extension is in the same position as the stock blade.....but due to different wheel paths that soon changes.
I have modified the swingarm adjustment slots so I can move the rear wheel further back thus lengthening the wheelbase and not so much to put more weight on the front but replace the weight due to the lighter Hossack front....also modern litre bikes make such good power now that a longer wheelbase really is needed to harness it.

Laurie
[Quoted text hidden]

Martin Lawson <lawson2@wisc.edu> Sat, Jan 31, 2015 at 7:32 AM
Reply-To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>
To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>

1) almost any forward movement of the front axle results in harsh ride and higher forces on the suspension. (especially when hitting large bumps) After two slow crashes due to underestimating this, I now aim for the instant-center of the front suspension to be below the front axle. (results in a vertical or rearward axle track) Note: wheel track and anti-dive can be optimized interdependently if you have enough flexibility in the suspension arm mounting points.

2) one of my early bikes has ~80% anti-dive at ride height. Braking has no effect on how harsh the front end feels. But there is no feel due to front end dive, and weight transfer is near instant, so it's easy to do stoppies. Note: I usually aim for a rising anti-dive with suspension compression. It has good feel, and tends to have better trail variation.

3) I'm pretty sure this is just riders adapting to the limitations of what they ride. It probably is useful to have the bike be more stable on when not braking, but consistent performance is all situations is useful as well. Also, You should be able to use less trail with most FFE suspensions. My AWD based on a Sherco has ~70mm trial, and is stable as fast as I'm willing to take it.

[Quoted text hidden]

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jac.brown@2020comm.net <jac.brown@2020comm.net> Sun, Feb 1, 2015 at 3:21 PM
Reply-To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>
To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>

Thanks Martin,

I appreciate input from you guys with experience. In particular, your experience with forward movement of the front axle resulting in harshness is great input. I've always wondered about the brake feel with high anti-dive as well. Thanks for the response.

Jac

[Quoted text hidden]

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jac.brown@2020comm.net <jac.brown@2020comm.net> Sun, Feb 1, 2015 at 4:12 PM
Reply-To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>
To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>

Hi Laurie,

I've been spending some time looking at your Photo Bucket and YouTube videos. It looks like you have built both a girder and a Hossack into very similar FireBlade bikes. Very nice design and fabrication by the way.

I was curious if you were willing to comment on the differences between the girder and the Hossack, and if it's possible, what's your favorite? I have been leaning toward the girder because of it's low steering friction, but I also notice that you took some nice measures to reduce steering friction in the Hossack. That is an amazing rolling ball ball joint.

Thanks in advance for any comments.

Jac

On 2015-01-29 00:42, Laurence Smith wrote:

[Quoted text hidden]

Laurence Smith <suspensionsmith@gmail.com> Sun, Feb 1, 2015 at 5:59 PM
Reply-To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>
To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>

No problem Jac
The main differences between the Girder and Hossack blades is steering agility.
The Hossack being such a more agile setup than the Girder.
The problem with the Girder is it has a lot of steered mass in comparison with the Hossack....the Girders shock and upper and lower links are a part of the steered mass and so have a lot of steering inertia which effects fast steering inputs.
The Girder also has poor mass centralization compared to the Hossack as more of its structure is further from the centre of the bike....its also a little heavier overall.

The Hossack design has very very low steered mass and inertia and I have improved this further by running steering geometry which allows zero wheel offsett to the steering axis....again reducing steering inertia.
For the steering bearings in the upright I am using in the upper pivot just a small ATV ball joint out of the Allballs catalogue...it is simple is very low friction and seems to be working very well.

The lower pivot is a bit more complex...as is the forces/loads being put through it.
It handles suspension loads as the shock is attached to the lower arm...it handles structural loads and sees higher structural loads than the upper pivot and it handles steering loads.
Now the thing with this pivot is it needs to give a very good feel through the steering when it is highly loaded and a good example of that is in the video showing me braking whilst leaned over....this is a very high load situation and requires a lot of finesse in the steering.
I think when people have used for example spherical bearing type lower pivots they may be setting themselves up for problems with stiction and friction in steering feel when this pivot is highly loaded in such a way.
I did look at using a spherical rollerball joint which look way cool but dont have the load capacity in the size I needed and neither had the range of angular movement I needed.

What I have done is make a pivot design that uses a combination of bearing types and which so separates the forces.....so I am using a needle roller bearing to handle the radial loads and a pair of tapered bearings to handle the axial loads and these bearings are sized to be well within their rated load capacity in relation to the actual loads they see.

This makes for a pivot that is heavier and bulkier but I think you cant put
a price on steering feel and this kind of performance in a race bike.
The proof of this to me is how the front feels and performs in that braking
Video...it feels bulletproof and gives a great feel through the steering
and of what the tire is doing etc.

Laurie
[Quoted text hidden]

Don Ricciardiello <don.ricci@me.com> Sun, Feb 1, 2015 at 6:32 PM
Reply-To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>
To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>

Does it work the tyre well?

Rgds,

Don
[Quoted text hidden]

Laurence Smith <suspensionsmith@gmail.com> Sun, Feb 1, 2015 at 7:38 PM
Reply-To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>
To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>

The Hossack seems to work the tyre well enough....because the Hossack is so
compliant in its action I need a combination of a high wheel rate and a
specially valved Ohlins TTX30 front shock that gives very strong low speed
compression damping.
The tyres are nothing special,just off the shelf Pirelli superbike slicks
in a normal SC1 compound.
You might notice in the braking test vid the presence of a small dash which
shows tyre internal air temp and pressure via a valve stem sensor in each
wheel.....this shows the front getting into a normal pressure/temp range
when being ridden and front grip has not been an issue.
But front tyre wear is noticeably low with a very smooth wear pattern....so
it probably could be better.
[Quoted text hidden]

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jac.brown@2020comm.net <jac.brown@2020comm.net> Sun, Feb 1, 2015 at 7:56 PM
Reply-To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>
To: MC-CHASSIS-DESIGN Mailing List <mc-chassis-design@micapeak.com>

Laurie,

Great explanation. Thanks for sharing.

Jac

[Quoted text hidden]