How Does Mountain Bike Suspension Work? Part 3 | Pedalling Forces.

PETE SCULLION · FEATURES · WEDNESDAY 23 MAY 2018

Ever wondered how your mountain bike's suspension actually works?

Wonder no more, our guest suspension expert Paul Mackie is here to break it down for you in easy to digest chunks.

Part 3: Drive chain and pedalling forces.

photos by Ian Lean / Roo Fowler / Pete Scullion / Jacob Gibbins / Red Bull

In this series, our man Paul helps break down the science behind suspension, putting the much bounded about jargon that fills bike chat into layman's terms.

If you missed the last couple, part 1 covers why we need rear suspension and part 2 is all about pivots.

Who is Paul you ask? He's a suspension nerd, engineer, not-too-shabby enduro racer. He has also designed a number of full suss and hardtail frames for a UK MTB brand.

Drive chain forces

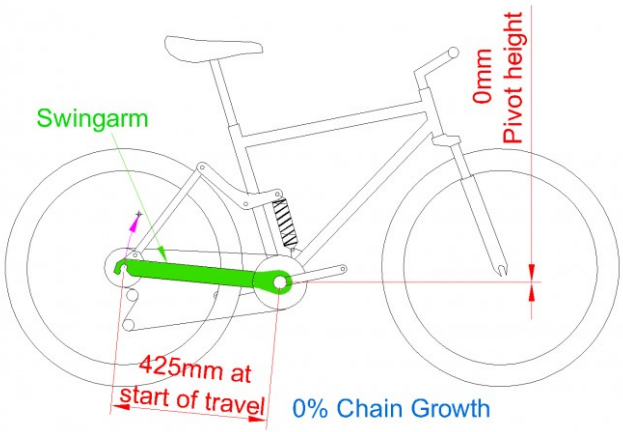
This is an aspect of mountain bikes that few riders think about but is very important to bike designers. Put simply, the forces acting through your chain can have a huge impact on how your suspension works.

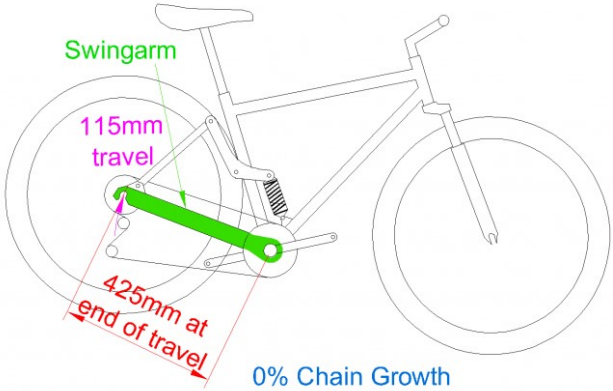
To understand drive-chain forces, it's good to re-consider the two extreme examples in Part 2: The 2007 Cove G-Spot and the 1993 Trek 9500.

It doesn't take a genius to work out that the swingarm movement of the Trek will tug on the chain as it goes through its travel motion.

Conversely, the drive-chain on the Cove is not affected at all by the swingarm movement because the swingarm pivot is concentric to the BB shell and crankset.

Chain growth

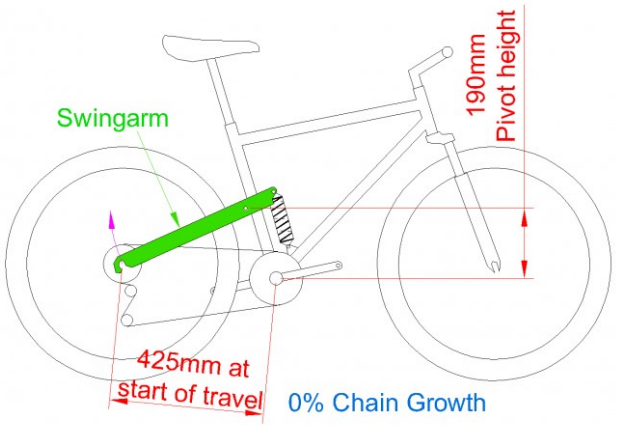


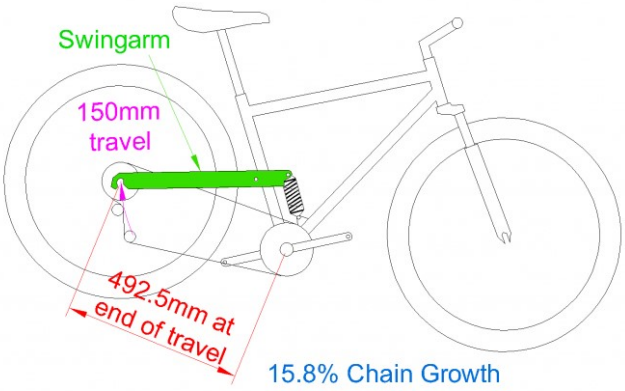


In fact, you could run the Cove G-spot single speed if you wanted to because there is no 'chain growth' (see the diagram above).

Chain growth is another term that gets banded around but in the simplest terms it the change in linear distance between the centre of the drive cog (typically the crankset centre/ BB) and the rear wheel axle at the start and end of the travel motion.

Taking the Trek and Cove examples again, the chain growth is shown in the diagrams below. It can be seen clearly in the Trek that the distance between the BB and the rear wheel axle is greater at the end of the travel motion. Whereas the Cove has the same distance between the BB and wheel axle, and therefore it has zero chain growth and thus there are no drive chain forces acting on the swingarm or suspension system.





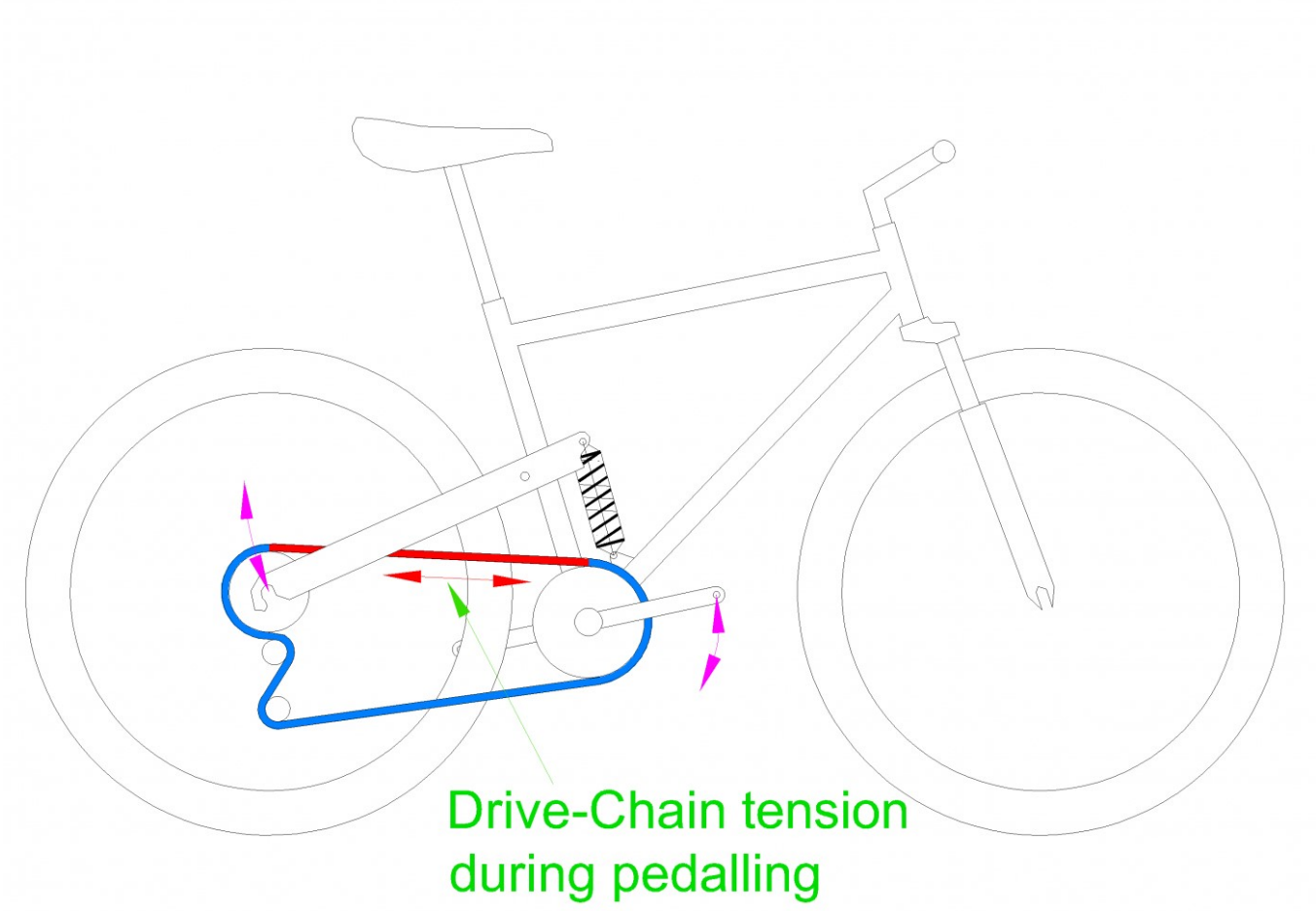
So why is there good and bad chain growth?

Looking at the Trek 9500 and Cove G-spot examples again, it can be seen in the Trek that during pedalling the chain tension is wanting to compress the suspension by pulling the rear wheel forwards and downwards, essentially 'locking out' the suspension movement.

So, for an XC rider, this can be a good thing. This 'locking out' of the rear suspension during pedalling counteracts the acceleration squat and bob effects mentioned earlier, both of which are considered undesirable.

If you didn't have any drive chain tension and chain growth affecting the suspension (the Cove G-spot), then the bike will bob and squat during pedalling. So, drive chain tension and chain growth make the bike more efficient during pedalling and therefore better, right? Not quite!

Too much chain growth and the suspension will not move freely when it encounters terrain obstacles because the chain is essentially stopping it. In addition, too much chain growth and the chain tension will produce pedal kickback as the chain is tugging against the crankset.

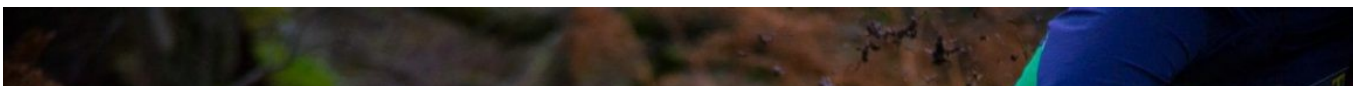


5% is the magic number

Most 'all-mountain' bikes have settled on a chain growth value of about 5%. This is why the majority of single pivot bikes place the swingarm pivot slightly above (say 70m) the BB centre. VPP/SDL and four-bar bikes are different because what we call the 'instant centre' (the swingarm pivot) migrates through the suspension travel.

Typically, the instant centre starts high (say 100m) and falls during the travel motion (to say 25mm) – meaning you get beneficial drive-chain tension earlier in the suspension travel when you are climbing and pedalling on the flat and not using much of the suspension travel. You then get low drive chain tension at the end of the stroke to avoid pedal kickback on big hits and landings.

When marketing types talk about 'anti-squat' in their suspension system, they are inevitably talking about beneficial drive chain tension described above. Conversely, when 'independent suspension' is mentioned, they are referring to a system with low drive chain interference.



Bullshit, in my opinion

Over the years, magazines and marketing material has talked about having pivots in-line with the chain line to create a suspension system that is 'independent' from drive chain forces.

This is bullshit in my opinion and the swingarm pivot is in-line with the drive chain by coincidence rather than by design. The chain line is directly influenced by the chainring size; therefore, the pivot location would have to be changed for a given chainring diameter for the argument to work.

Furthermore, there is no difference in the drive-chain influence for Cove G-spot with zero chain growth regardless of the chainring size and resulting chain line.

In summary, unless you have a swingarm pivot that is exactly concentric with the BB, then you will have some amount of chain growth and thus drive chain influence over the suspension.

Shocking Bob and Squat

So we've learned that chain growth and beneficial drive chain forces counter the undesirable bob and squat motions in the rear suspension system during pedalling.

So surely modern rear shocks can deal with this now on their own? This is partly true, but setting the compression exactly right for every rider weight and style is very difficult.

A system that relied on the shock to be carefully set-up by the rider to counter bob and squat is unrealistic as the majority of consumer market out there probably doesn't have the expertise to do this.

Therefore, as a manufacturer, you can over-ride suspension setup mishaps with a well-designed 'anti-squat' and 'anti-bob' system which provides more suspension movement resistance in relation to an increase in rider exertion. In other words, the suspension system automatically reacts to rider input.

Decoupling Aaron Gwin

Arguably one of the most famous DH wins of all-time was Aaron Gwin's chainless run at Leogang in 2015 when his chain snapped just after leaving the start gate.

What this proved is that a suspension system can work very well when chain tension forces are removed and there is no need to pedal. However, in practical terms, pedalling is essential for 99% of rides.

One of the most curious and innovative suspension designs in recent times is the Canyon Dis/Connect DH bike which has a remote switch that decouples the freehub drive thus removing drive-chain forces from the suspension system and allowing the swingarm to move freely.

Although clever, this is probably not a practical solution to the problem, but it does demonstrate what is going with regard to drive chain forces!