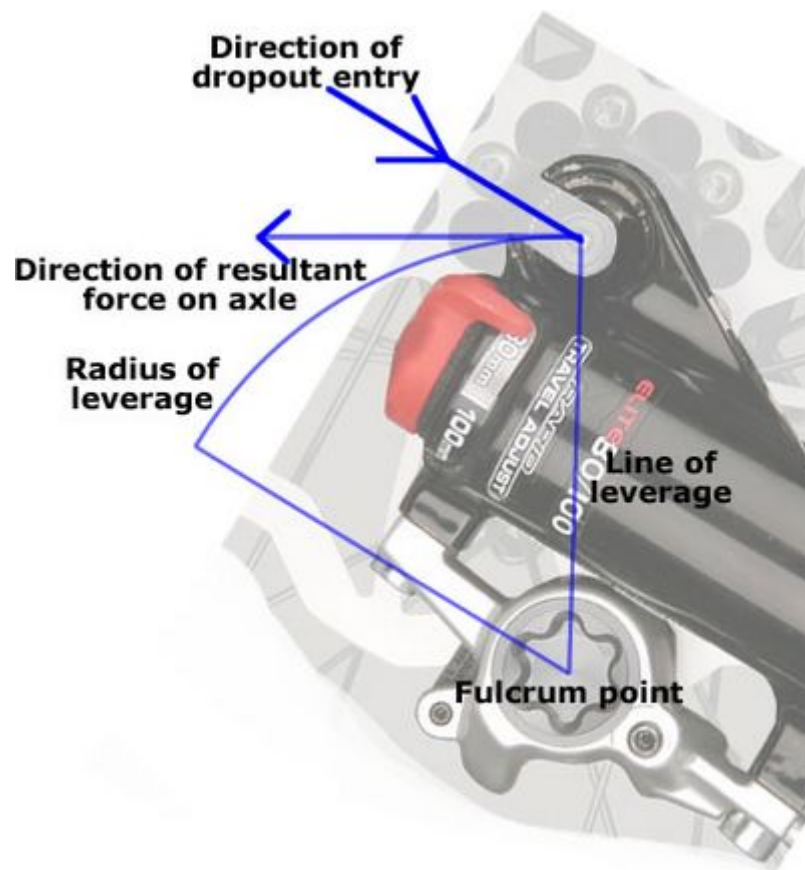


## Disc brakes and MTB forks: Independent testers verify axle slippage and QR loosening

A German product safety lab's testing rig has found axle slippage thanks to disc brake ejection forces. And a Glasgow bike-shop owner with a physics degree stopped a 'real world' QR test after just three days when a disc-brake equipped bike was found to have a QR loosened by a full 10 degrees.



Even though he has now replicated part of Annan's QR/disc brake theory, Ben Cooper of Kinetics, a Glasgow-based retailer of recumbents, electric bikes and other specialist machines, believes the theory is not as serious as Annan claims.

*For full coverage of the Annan theory to date, type 'Annan' into the search engine box at the upper far left of this site. There are now ten articles.*

Ernst Brust of Velotech.de, a privately-owned, industry-respected testing lab, has tested Annan's theory on Velotech's suspension fork testing rig and found clear cause for concern.

Brust told BikeBiz: "The industry can no longer afford to ignore the questions raised by passing them off as users' mistakes."

This has possible ramifications for fork makers and bike suppliers who spec the kind of forks that

appear to allow the theoretical possibility of wheel ejection under extreme loads. Moulds for 2004 forks are now done and dusted, and many 2004 bikes are being equipped with forks that may be subject to recalls.

Some fork makers have told BikeBiz they are now taking Annan's theories very seriously and are making design changes but will not be drawn on when their modified forks will be ready for market.

The US Consumer Product Safety Commission, and other international consumer safety bodies, are already conducting their own tests, doing literature searches and seeking consumer accounts of wheel ejections thanks to potential disc-brake/fork design flaws.

Bike expert Jobst Brandt from America, author of the classic book *The Bicycle Wheel*, supports Annan's theories:

"The mechanism has been clearly stated, the forces have been identified in magnitude and direction, and credible descriptions of failures have been presented. What's going on here? There is no Easter Bunny. Believe it!"

### **Kinetics**

QR loosening was covered in depth on James Annan's website and he quotes BoltScience.com to back up the fact that bolt loosening isn't merely caused by vibration. BoltScience.com in turn quotes 1960s research that indicated that transversely applied alternating forces generate the most severe conditions for self loosening.

<http://www.boltscience.com/pages/vibloose.htm>

Ben Cooper of Kinetics decided to put this part of Annan's theory to the test.

"My usual commuting bike is equipped with disc brakes. It has titanium quick release skewers, and forks with no 'lawyer tabs'. In over a year of use, I have never had to adjust the quick release. It was tightened as hard as I could get it by hand.

"I retightened the skewer using the '90 degree rule'. This rule is often quoted for quick releases - you tighten the nut so the lever starts to get tight when the lever is at 90 degrees to the wheel. So this was looser than I previously had it, but still hand tight. The lever was on the right side (opposite to where I normally have it, but consistent with advice from SRAM and others).

"I then rode the bike on my usual commuting journey - 6 miles per day, on and off road, including cattle grids and speed bumps taken at speed. Every day I loosened then tightened the lever, and recorded the angle at which the lever began to bite.

"I repeated the experiment on a V-brake-equipped bike - the same skewer was used over the same route."

On the V-brake equipped bike the QR's bite point was found to be still at 90 degrees after a week of riding. However, on the disc-brake equipped bike, Cooper halted the experiment after three days when he discovered the bite point had shifted to 80 degrees.

His conclusion?

"There seems to be an effect from the disc brake which causes the quick release to loosen. Since this disc bike was used with the same skewer for over a year with no adjustment, it is apparent that this effect only occurs if the skewer is not tight enough. There is a certain critical limit. Below this limit, the skewer can loosen. Above this limit, it won't. The limit is dependent on skewer design and rider weight."

But Cooper isn't convinced there's a massive safety issue at stake:

"[Annan's] initial analysis is correct, the force diagrams and calculations he details are accurate, and as someone with a degree in physics, I have no problem with that part of his theory. I am less sure about the consequences of the basic maths.

"In Annan's analysis, the two forks legs are assumed to be independent - the force from the disc brake is assumed to only act on the left dropout. I do not believe that this is correct in practice. Imagine what happens if the axle starts to come out on one side only. First, the disc rotor will have to be deflected - this requires quite a bit of force. Then the skewer will also need to be stretched by an amount proportional to the displacement of the axle. Thirdly, the axle cannot move far before the rim of the wheel contacts the inside of the fork leg - in most case I tested, it is not possible to remove the axle on the left side only.

"So, basically, the force generated must be enough to overcome the strength of the serrations on both sides of the fork, not just the left side.

"I have talked to a number of technical people at various manufacturers, and they have never seen this problem with their products. Yes, they could be covering up - but these were off-the-record discussions with non-lawyers so I do not think so.

"I believe that there is a possibility of a problem with some combinations of components. Unlike James Annan, I do not believe that there is a fatal design flaw with all combinations of disc brake, fork and quick release."

[http://www.kinetics-online.co.uk/html/disc\\_brakes\\_\\_grs.html](http://www.kinetics-online.co.uk/html/disc_brakes__grs.html)

### **Velotech**

Also known as Dienstleistungszentrum für Produktsicherheit, the Institute for Product Safety, Velotech is a Schweinfurt-based testing lab with bike-specific testing rigs that replicate real world riding conditions.

The company was founded in 1991 by Ernst Brust, a former employee of FAG bearings and then technical director of Winora, the German cycle manufacturer.

Brust was made aware of Annan's claims via the coverage on this site:

"I have been following with close attention and great interest the articles as they have been appearing at BikeBiz."

And after doing his own testing, he said:

"The industry can no longer afford to ignore the questions raised by passing them off as users' mistakes."

Brust believes design mistakes have been made:

"Development in the field of components has taken place in leaps and bounds. At the same time established dimensions in components have been retained in order to facilitate the introduction of new sub-assemblies to the market. The use of these new developments without due consideration has frequently led to new safety problems in other areas.

"Drop-outs on forks have been optimised for the use with rim brakes. Without the necessary critical re-examination, new disc brakes have been introduced – and this has led to problems."

In fact, Brust has been aware of disc-brake/fork axle-slippage since 2001, long before Annan raised the issue on his website.

"Tests which we have carried out since the end of 2001 have shown that front wheels can be pulled out of forks under certain circumstances. This has been known to happen to rear wheels as well, but accidents involving rear wheels seldom have serious consequences. Accidents involving front wheels inevitably lead to falls.

"The manufacturers concerned have hitherto denied that risks were involved, while at the same time improving the design of their forks."

Brust doesn't believe the industry has yet made enough design changes to eliminate the axle slippage

problem. His attempts to interest fork manufacturers in the potential for slippage due to some current fork designs have not been wholly successful.

Until now. The coverage on BikeBiz.co.uk, and the follow-up coverage in German trade magazine SAZbike and US trade magazine BicycleRetailer, has raised the profile of the possible design flaws at work in the Annan theory.

And now Brust is working on new, more exhaustive tests:

"The very first hard braking loads led to movement in the axle. Fatigue testing on a roller drum test rig will demonstrate whether or not the drop-outs are adequately designed for the loads to be expected in long-term use. Road jolting and brake loading are tested in combination. Since testing is not yet completed we cannot as yet comment on any results."

Velotech's testing rigs simulate the impact from the road surface through strips of varying height on a roller drum, at varying speeds, and can simulate out-of-saddle riding, rapid descents, jumps and braking loads.

Much of Ernst Brust's work has been illuminated by co-operation with Dr Eric Gross of the technical university of Hamburg-Harburg. Gross is an expert on the determination of operational loads on mountain bikes (see, *VDI Verlag GmbH, Düsseldorf, Reihe 12, Nr 308*). And Brust helped to devise the DIN cycle standard (DIN 79100) in 1997 and later introduced the certification programme "DIN plus for bicycles and components" for DIN CERTCO Ltd.

Brust's business partner is Klaus Masek, former technical director of the German bicycle federation and former chairman of the German bicycle standards committee.

<http://www.velotech.de/html/english.html>

#### **What's to do?**

On their respective websites, both James Annan and Ben Cooper have proposed short-term solutions to the Annan theory, solutions that could prevent fork recalls.

What would be most helpful - and tests are currently being undertaken by a number of parties - would be a list of forks and component combinations that allegedly do and do not fail the Annan theory. Some combinations are said to be much riskier than others.

A UK IBD has claimed that a Trading Standards officer told him - off-the-record - it would be wise to clear his sales floor of disc-brake equipped bikes. The Annan theory, yet to be proved in its entirety, is slowly moving into the mainstream. The bike trade cannot afford to dismiss the theory out of hand.

PIC COURTESY OF: Simon Watts <http://www.siwis.co.uk>