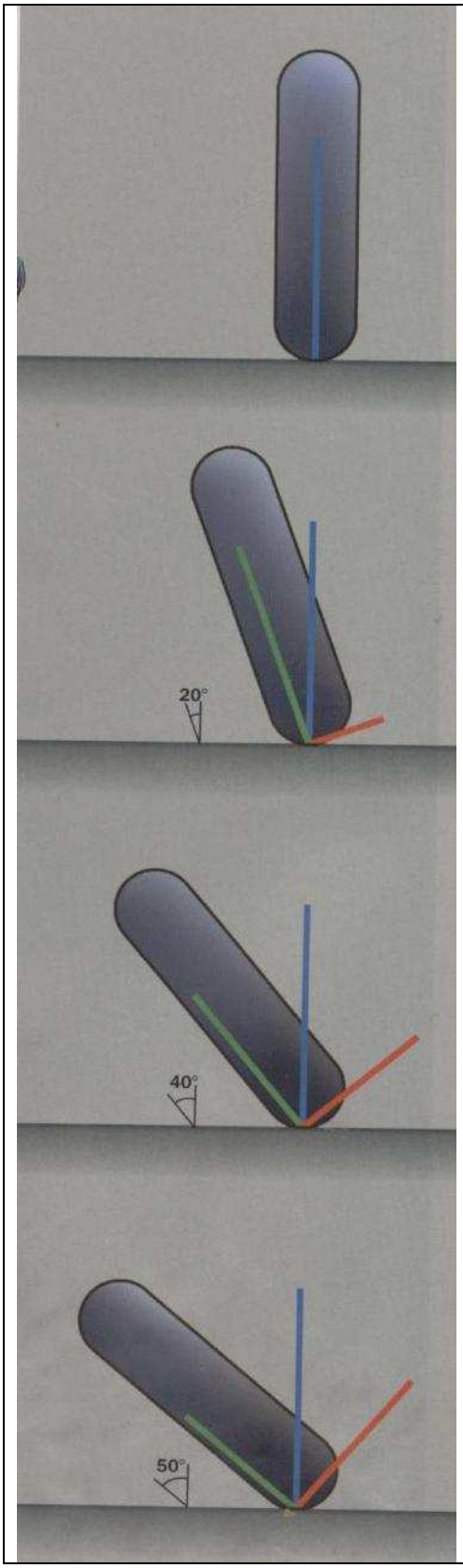
Last night I spend more than an hour on my attic, looking for an article on frame-stifness that appeared in a belgian motorcycle magazine, and that I new would be a good thing to post in the Ducati-going on's about the flex off heir frame. I had to go way back to 2003 before I got it.
It's written bye Steven Casaer. Some off you might have heart off him. He is no frame developer, but he has a degree as industrial engineer. He also raced lot's off different bikes in Belgian championships, EK superstock and endurance. When the MW Agusta F4 750 came out, he was the first to start racing endurance with it. I knew at the time there was some controversy about the bike, since it appeared to be a superstock bike but had to race in the superbikeclass, but more importantly since it was only a 750, everyone wondered why it was as fast as the 1.000's, specially since it was a very small team with just a van with a bike in the back – very unlike the SERT's and YART's etc … Lot's off years later, he unveiled in the magazine the story behind it : he was quickly picked up bye the MV-factory : they thought he's team was a perfect platform to develop their 1.000 F4, so that was what they raced : the 1.000 F4 before it even excisted, and in fact it's his team that for a large part developed the F4 1.000. He worked as development rider for Wolbers-suspension, and in 2005 he started his own company (Emc37) setting up/ preparing race-track-road bikes. He also worked/works for YART/Kawasaki france superbike + endurance and and Kawasaki/Yamaha in IDM as telemetrist-suspension specialist. Just to say the man is no "keyboard-specialist" like me, but he know's some shit about bikes ;-)

I'll try to give a breef translation off the article, because it's in Dutch and I don't suppose many off you can read that :

That a stiffer frame isn't always better is bye now knownbye every well-informed biker. A too stiff framegive's no feedback to the rider and isn't capable off "helping the suspension" to keep the bike on track. On straights it results in dribbling when going over any(little) bump and a complete lack off filtering engine vibrations. A very stiff frame takes over any movement from the front wheel over uneven surface without extinguishing it. On the contrary, the movement is translated into a "vibration" off the entire bike. On lean angle, a too stiff frame results in difficult vaguely steering and in almost unresolvable problem's in suspension-setup. Because, suspension set-up asks for 2 things that are contrary to each other : stiffness to cover the "sportiveness" off the bike, and softness to filter out bumps etc, and a stiff frame is not helping at all with this. When on lean angle , the forces working on the bike/suspension are no longer in the centre lineoff the suspension. Still all those forces must be delt with adecuatly, otherwise the bike will start to dribble.



On these pictures, the disturbing force (like a bump) is colourd in blue.

On lean angle, the force isdivided in 2 components : the green one works on the suspension, and the red one perpendicular on the green works on the frame. It is clear that when the lean angle get's bigger, the force working on the suspension get's smaller, and the one on the frame bigger. Because the component on the suspension get's smaller all the time, suspension should also be softenend for it to filter out uneven surface adequaltly.

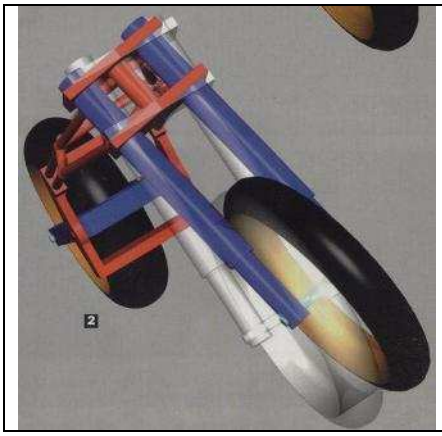
This presents a dilemma to the driver : the faster you go, the harder you'll wan't your suspension (harder braking = more dive, so you'll need stiffer springs to cope with the bigger forces) to be, but also the harder you go, you'll have more lean angle so you'll need softer suspension.

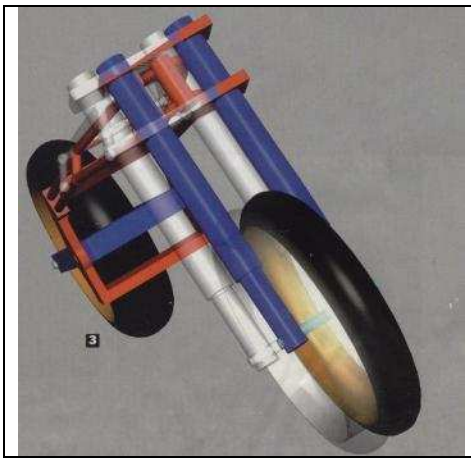
No easy task, setting up suspension ;-)

Still, perpendicular to the plane where the suspension works in, there is a growing component of the force caused by the bump. That component can be delt with more efficient to filter out the unevenness, but that has to be done in the right direction.This can be done by 2 things : the forks or the frame can bent.
A bending fork is the easiest solution, but practice showas forks are made as stiff as possible. The reason is the friction between the inner and outer leg : a bended fork suffers from clamping, the so called "stick-slip" and that disturbes the working off the suspension.
So a better way to deal with the force is the frame . Though that consesnsus doesn't excist for long. Bikes with a very stiff frame that are difficult to handle : Appart from Haga, no one else managed decent results with the upper-stiff R7, and the same goes for the VTR SP1 from Colin Edwards : last year with the arrival of the SP2, they solved the problem with the frame by simply deleting the bolts that bolt the front cylinder-head to the frame. That way, the "none-fixed" beams of the frame became longer, creating more felx in it and because off that, dealing with bumps in corners and under acceleration was more efficient.

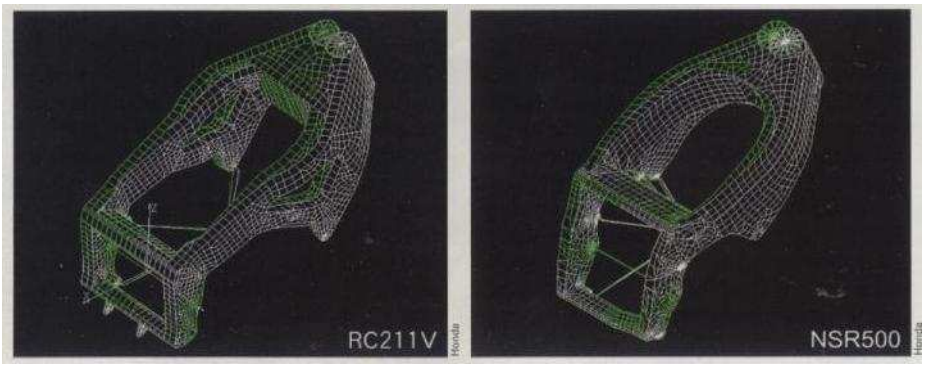
Now the big question is where you want the frame to bend and where not !
Forks will always bend a little, same goes for the swingarm. If both wouldn't do that, we would have less traction, and regularly we would see frames brake up. Yes, because forces under braking and acceleration are from an order that can not be underestimated. Fact is though, that the rolling frame also has to be able to deal with much smaller forces like uneven surfaces. What we don't want is that the handling off the rolling frame in negatively inluenced. So we have to chose carefully where and how much flex we put in the frame. Choices have to be made, and this is the right moment to separate some things.

When talking frame-stiffness, there are 2 kinds : torsion and lateral.

	*When torsion happens, your wheels no longer point in the same direction, but come in a cross-plane to each other. This flex always has a negative influence on handling/steering and must bye all means avoided. In other words : you can not have enough torsion-stiffness !*

	*Lateral movement here means that although the wheels are no longer on the same centre-line, they still are parelell and they will keep on traveling in the same direction.* *This is the movement we want, it's this flex of the frame that implements the "suspension-factor" of the frame*

When switching from the NSR to the RCV, the RCV-frame could withstand tortional flex better bye 23%, while lateral flex was reduced bye 17%. This was needed because off the higher weigh and more power.



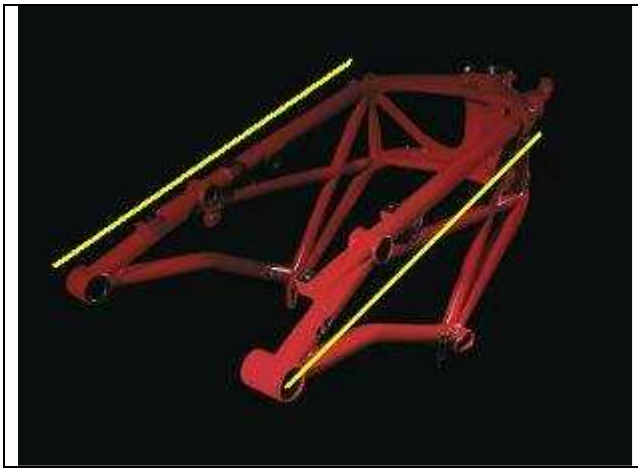
So where want we the flex ? Just as with all other forces, we want them to act as closely to the CoG as possible, and that is somewhere at the back of the engine, above the swingarm pivot. If you look at the piture off the RCV frame, you'll see that it's just there the the beams off the frame are the thinnest. Another example : if you look at the MV-Agusta F4 frame, it consist of a trellis frame that is perfect for dealing with torsional forces, and has aluminium parts at the back, close to the CoG that allow lateral movement.

So good thinking is the message when you want to build a new high-performance frame. Torsion-stiffness should be maximalised, *but lateral-stiffness should be* optimalised. *A less rigid frame demands less from the suspension, but downside is that improvements to the suspension don't deliver all the expectations. And a less ridgid frame in many cases has the same problems as a too ridgid frame : no accurate feeling for the rider with the same problems regarding feedback from the rider to the team.*

End off article.

So what do I make off this all regarding the carbon-frameless-Ducati ? and why is it that the same design with a Trellis worked, and doesn't with carbon ?

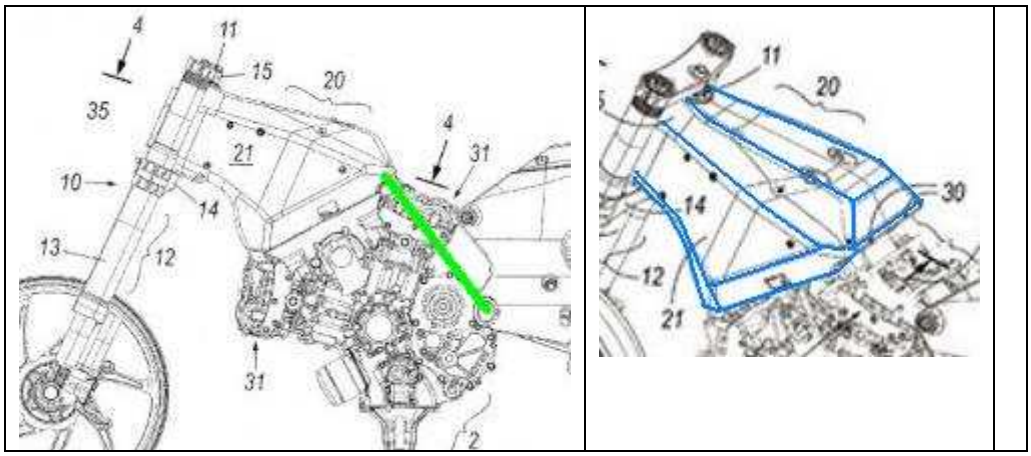
Let's look at the trellis :

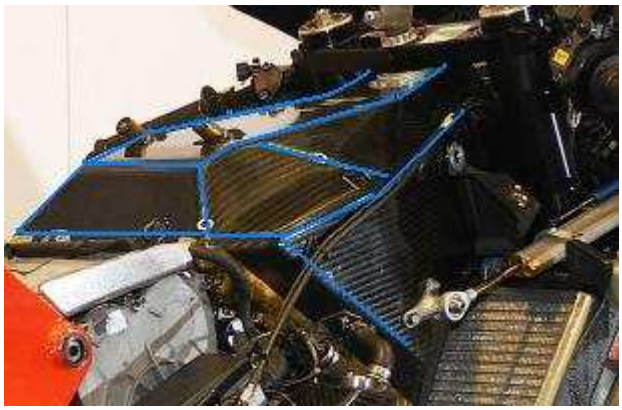


Triangles are the best way to prevent something from bending, as long as the bending takes place in the same plane as the triangles (look for example at metal buildings : rectangular metal beams with diagonal reinforcements creating triangles). It's also quite impossible to distord a triangle : that would mean one beam to grow in length, and the other to shorten.
Look at the left picture (I know it's from the Desmosedici and is slightly different in the tubing, but it has the same shape) : each side off the frame has plenty triangles, so it's hard to deform it. But both are parallel to each other with no triangles between them, only straight connections (through the engine and headstock) and making a rectangle. And a rectangle can easily be deformed. On the left pictured : I marqued the distance from where the back off the frame is fixed to the engine, and you can see it's close to the swing-arm pivot. In blue on the right is the length off the frame that allow's the lateral flex.

So translating the article on the trellis-frame : they have done a very good job preventing torsional flex and allowing lateral flex. And no one had real problems with it .

Now we look at the carbon frame :





it's difficult finding decent pictures off the carbon frame, but I thinck these will do.
The left top one : you can see clearly the the sub-frame is much further away from the swingarm pivot. This has 2 downsides : the length off the frame where it can flex is shortenend, and the place where the flex can occur is moved away from the CoG. Both things are not OK according the article.

Top right picture and bottom one : I tried as good as possible to outline the shape off the frame. As you can see : no rectangle's. the more you go away from 90° angles , the more difficult it is to deform something.
Comparing with the trellis : looked from the side it's almost like a triangle (and a full one as opposed to the trellis) ; this will not deform easily. Good jo one would say.
But if you look from the top : it's also close to a triangular form, and it is not even flat, there is another shape on top of it. It's a bit like curved cardboard (you say that in English ???) : all the shapes together make it very strong.

My conclusion : in the carbon frame (although it's hollow), you can not have the lateral flex where it ought to be, and there is not much lateral flex possible in the frame : there is no rectangular, and all the different shapes combine together into a solid strong thing. If it flexes (which no doubt it will do) , I believe it will bend and twist as much, there looks to

be nothing preventing it to twist since it appears to be as solid any wich way you look at it).

So comparing both : although it's the same concept (frameless bike), the outcome on lateral flex is totally different.

And comparing both frames to the Japanese : the trellis has the same shape (compare it to the RCV frame) and does the same : it "bends like a tree in the wind" : a tree just bends in the wind and doesn't twist. The carbon frame : I can't tell exactly what it does, but I'm quite sure it's not a tree ;-)