

TRI TEST now also for forks

To receive an EFBe test certificate, frames already have already had to pass a TRI TEST for some time. In addition to passing the fatigue tests for the requested EFBe performance level, the test specimen must prove their quality also under maximum load and under overload conditions. This ensures comprehensive safety, regardless of the frame's material.

In practice, metal components tend to exhibit mainly fatigue problems, while carbon more commonly fails under overload. Occasionally, however, carbon components can experience fatigue failure and metals overload failure.



Illustration: Overload and peak load testing of forks

Because this applies not only to forks, we have now gone one step further: As of the beginning of this year, a TRI TEST for forks is also required for the certificate. In addition to an

EFBe fatigue test, the specimen must pass a static maximum load and overload test. The test setup simulates the load conditions under emergency braking: The force is applied in the area of the front wheel contact point at angle α to the contact point radius and the braking force is applied to the fork according to the type of brake. This setup has already proved itself in the course of a year's testing.

Requirements have been laid out for three bicycle categories:

EFBe recommendations				
	Max. gross weight	Test angle α (°)	Max. load (N)	Overload (N)
Racer	110 kg	33	1300	1800
MTB	115 kg	33	1500	2100
Trekk/city	140 kg	41	1800	2500

Because of the additional weight of the luggage acting on the rear wheel of trekking/city bikes, the maximum brake force acting on these types' forks – always assuming optimum brakes – is actually higher than for bicycle types without luggage rack.

An interesting fact for frame manufacturers: The combined maximum and overload test can not only be performed on the forks in isolation (steering head angle 70 degrees), but also on complete frame-and-fork sets. In this case, the down tube or the gusset in the area of the steering head is also tested to establish whether its dimensions are sufficient.

New: Track rigidity tests for frame sets

Rigidity measurements are usually applied to the frame in isolation. But especially for racing bikes, the rigidity of the complete set – consisting of frame, steering set and fork – is an important factor. On the test rig for out-of-saddle rigidity it has already been possible for many years to test a complete set's rigidity. Now this

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test is also possible on the track rigidity test bench.



Illustration: Track rigidity testing of complete frame sets

This is done by fitting a road wheel dummy into the fork, the set's rigidity being determined in the same way as that of the frame alone.

When comparing rigidity values, the type of rigidity must be considered: of the frame alone or of the entire set. The set rigidity is, of course, always lower than that of the frame alone. The reciprocal values of all individual components' rigidity – the so-called compliance or elasticity values – add up to the total compliance, whose reciprocal value, in turn, is the overall rigidity.

Rear frame fatigue testing project

Disk brake rear frames of some MTB models are known to occasionally experience service fractures in the area of the left dropout. The cause is considered to be repeated, hard rear-wheel braking, which can induce significant moments in the rear frame through the sudden deceleration of the rear wheel. Another cause could be high axle loads on drops.

Our project aim was to simulate known damage to rear ends through fatigue testing frames of identical design and to suggest a possible

method for the specific testing of rear drop outs. An important goal was to achieve fracture patterns that matched the service fractures as closely as possible. Models without service fractures should, as far as possible, pass the rear end test.

In cooperation with three manufacturers we investigated 17 MTB (full-suspension) frames. Of two of the tested models two different versions were available: one with an unacceptable rate of failure with a constant fracture pattern and a new, stronger version without known service fractures.

Unfortunately, the service fracture behaviour was not known exactly in all cases; to the extent that it was, a very good correspondence was partly achieved, as the two photos below show.



Illustration: Service failure in rear end



Illustration: Test bench failure on axle load

As expected, braking and axle loads resulted in distinctly different fracture patterns. The photo below shows that fatigue cracking under braking force originates at the underside and not – unlike in the picture above – at the top of the cranked chain stay.



Illustration: Test bench failure on brake load

As of now, both rear end tests are available on request as special tests, either instead of or in addition to the TRI TEST. EFBe's recommendation for MTBs is:

- A. Braking (350 mm lever): 100 000 × 400 N
- B. Vertical axle load: 100 000 × 1900 N

Prototypes in the lab

The strictly confidential treatment of our partners' test results is an integral part of our business principle. At the same time we strive to operate an open lab and to avoid excessive secretiveness. In other words, if you have some level of knowledge about the subject, you will readily be able to see how we perform tests and what is being tested. You may see broken test specimen of well-known brands, but we will not share with you information about the conditions under which the parts failed. As you know, nothing is impossible to break...

When commissioning testing of a prototype that must not be seen in public, requestors can include a short note to this effect on their test order. The specimen will then be kept under lock and key.

Recommendations for EPACS (Pedelects)

In August 2007 a draft of EN 15194 was published, which also specifies EMC (electromagnetic compatibility) requirements for bicycles with electric motors. The standard is to be published this spring and will apply in addition to the requirements of EN 14764 for trekking and city bikes.

The informal annex of the German edition of EN 15194 is to include a non-binding recommendation to apply more stringent or additional fatigue requirements than those specified in EN 14764 for fork and frames of bicycles with electric drives in the front-wheel axle.

For the frame we recommend at least the "EFBe High Performance S" full test, which exceeds the fatigue requirements of the EN standard and in addition covers the potentially fracture-prone steering head area.

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Current frame test statistics

For an objective assessment of EFBe's test results, it is helpful to know the results of all performed tests. The table below gives an overview of fatigue tests grouped by frame type and performance level. The figures show the percentage of passed tests relative to the total number of tests in each category based on 302 Full Tests.

	MTB	Racer	Trekk./city
TP	54	59	42
HP	65	52	88
SP	70	82	-

Fatigue test statistics: percentage of full tests passed (as of 2009-01-01) Data are displayed only where more than ten tests were made in a category.

The Max. load and Overload tests were passed by most specimen:

- Overload, drop (based on 51 tests): 96 %
- Overload, pedal (based on 49 tests): 82 %

For the rigidity tests, all bicycle types were summarized in the analysis. The following tables show the percentage distribution of all measured frame rigidity values, with notes given from 1 to 5 as introduced in the Newsletter of 16 February 2006. The figures are based on 156 track rigidity tests and 153 out-of-saddle rigidity tests.

Note	1	2	3	4	5	Σ
Track rigidity ≥ (N/mm)	10	8	6.5	5	0	
%	7	24	29	29	11	100

Statistics: Frame track rigidity tests
(as of 2009-01-01)

Note	1	2	3	4	5	Σ
Out-of-saddle rigidity ≥ (N/mm)	150	120	100	80	0	
%	15	9	31	35	10	100

Statistics: Frame out-of-saddle rigidity tests
(as of 2009-01-01)

Note that these figures, while providing guidance, are not representative.

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Dates for your diary

2009-11-12/13 DVM Workshop Berlin: "Test methods and quality assurance methods under consideration of carbon fibre materials"