Performance and handling: the road to paradise is paved with carbon fibre.

LIGHTNESS

It's taken for granted that bike components need to be light and the less they weigh, the better the performance will be. This is doubly true for rotating parts and for all the parts which move with the suspension. To move anything requires energy and this applies to things like suspension springs as much as it does to wheels or engine parts. The only source of energy is the engine and any unnecessary fritterage leaves less for the grand purpose of winning races, getting home of an evening or broadening the grin at the end of the country lane, depending on your tastes and inclinations.

So the weight of things like wheels is super critical. But it is not the only reason that lightweight materials are sought for wheels or even for engine castings. Stiffness is just as important.

STRENGTH

Anything structural on a bike has to be strong enough to take the worst that's likely to happen to it, plus a small safety margin. But beyond this obvious requirement, strength is unimportant. Undesirable even. Steel is three times as strong as aluminium alloy; but it is also three times as heavy. The implication is that for a certain level of strength, you are forced to carry a certain amount of weight.

In some components this is broadly true. But only in parts where strength is of paramount importance. There aren't many of them: connecting rods, piston pins, gear teeth, valves, certain bolts...
They're nearly always steel. Or titanium.

For most other parts, strength isn't as important as stiffness. These parts are usually made of aluminium alloy, magnesium alloy and, increasingly, carbon fibre or other composites.

Usually, of course, parts need a blend of strength and stiffness. But there are plenty where ample strength comes from the sheer volume of material. Perhaps wheels, brakes, frames and swing arms come into this category. In this case there is an argument for finding a material which is *weak* . The reason is that such materials are usually light and so a given amount of strength or weight will occupy a greater amount of space and it is this *shape* which gives the high level of stiffness.

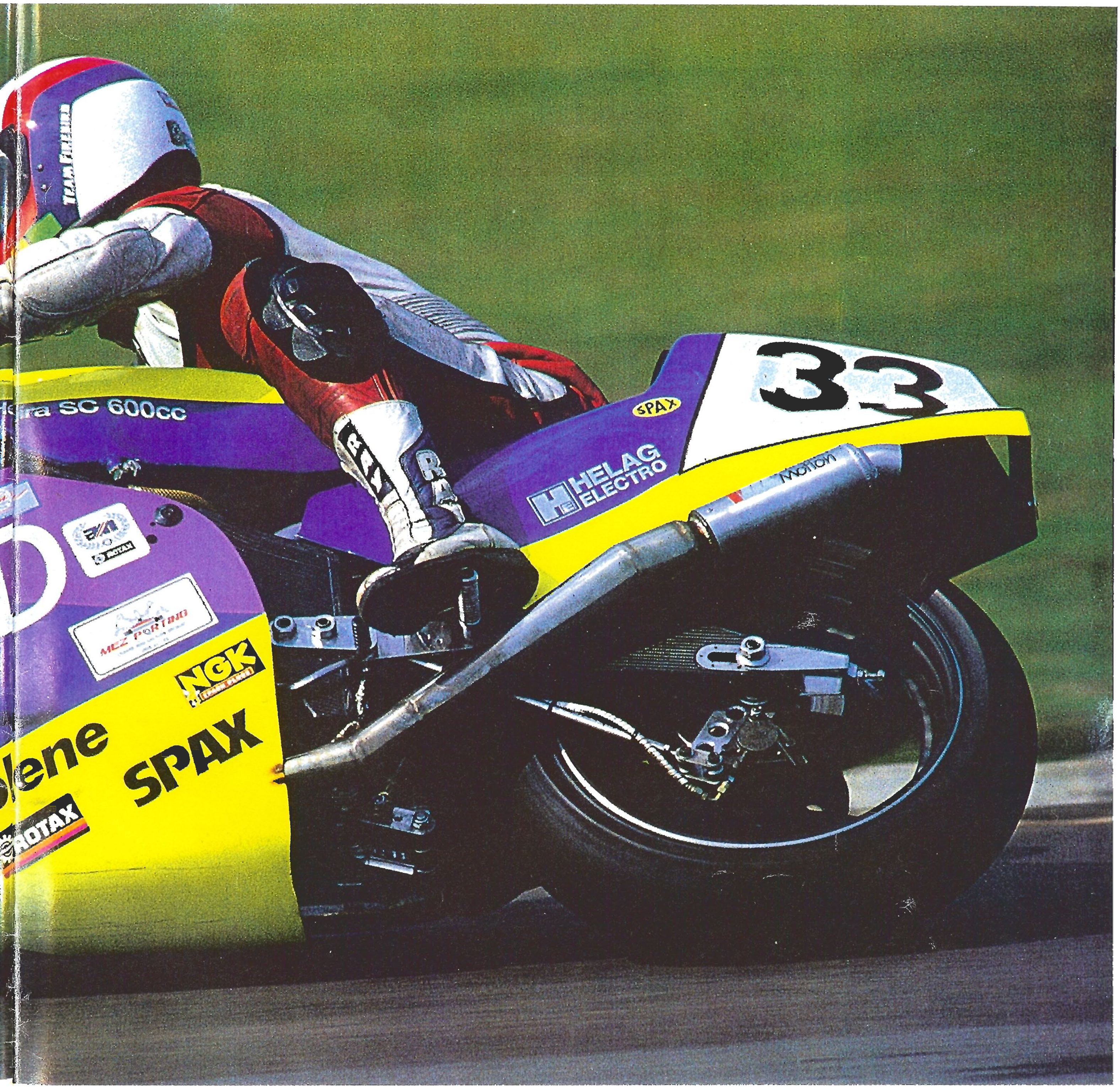
STIFFNESS

Is not the same as strength. The strength of a material is how much force is needed to break it. Stiffness is how much (or rather how little) the part deflects when it is loaded, and this depends as much upon the shape (and the type of load) as it does on the material.

Example. A steel rule. Flat side on, it is springy and easily bent. Edge on, it is incredibly stiff. It is the same steel, the strength is the same.

But if alloy is one-third as dense as steel and has one-third the strength, then strength for strength, or weight for weight,

All Stiffnes

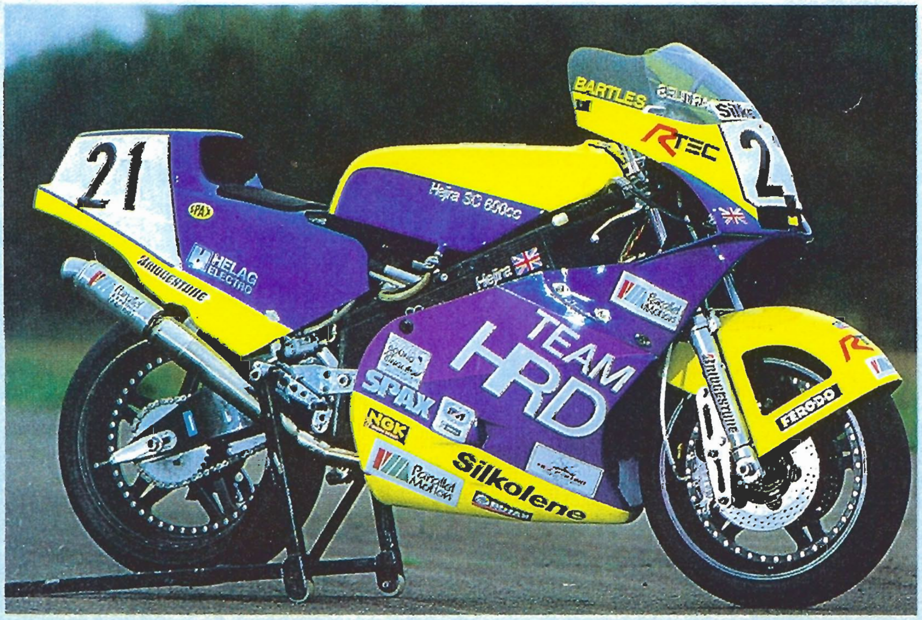


where is the advantage? Take something like a crankcase. Its job is to hold all the running bits and keep them all in line. If it flexes, it will tighten up on some bearings, or will twist meshing teeth out of line and increase the friction between them. Some cases distort when the bolts are tightened up. CBR600s were famous for it. Eventually you cannot turn the crankshaft by hand.

If a crankcase were made out of steel, it would either be very thin, like the sump pan of a car, or it would be very heavy. Using aluminium alloy means that much thicker sections of material (three times as thick) could be used, for the same weight. And where the material is only there to provide a continuum, to join one bit to the next and to keep the oil in, it can be kept thin. This leaves more material to be stacked up in the sections that need to be stiff. Using a material which is weaker, but lighter, means that it can occupy more space and, like the ruler edge on, it is more resistant to deflection because there is more of it.

s and Light.

All Stiffness and Light



120kg of pure hedonism freshly baked this morning and powered by Rotax.

Hejira

Armstrong, Heron Suzuki, Honda HRC, Team Roberts, Aprilia and Cagiva have all flirted publicly with composites. Many more have probably dallied in private. But in recent times only Britten and Hejira have actually raced with structural carbon fibre on a regular basis and Hejira are now offering their chassis parts for sale. In addition there are carbon fibre wheels available from Kudos, Marvic and Carbontek.

While it is relatively easy, if expensive, to make carbon fibre parts, it is not so easy to exploit the material to the full, or to optimize the bike to take full advantage of it. For a start, there is a fair amount of reluctance to accept new techniques, especially after episodes like the collapse of F Spencer's rear wheel at Kyalami. But that was ten years ago and is offset by the list of things that haven't collapsed... viz, Tornado wings, various tennis racquets, most of the A320 Airbus, F1 racing cars, helicopter rotors and now even the shafts that drive the rotors.

With any new technique there is a tendency to follow what is known to work in the old — in metal frames, in this case — and to over-engineer parts for safety's sake. The Hejira Rotax weighs 120kg dry — light but not enough to raise eyebrows — although the chassis has been measured at 20 times stiffer than their steel version.

Derek Chittenden, the engineer responsible for Hejira's design, is understandably cautious. The frame has temperature-sensitive strips all over it and he has many samples of carbon fibre in jars containing all manner of solvents, hydraulic fluids and other unpleasant liquids. Some have been there for two years and so far the carbon material has been reassuringly inert.

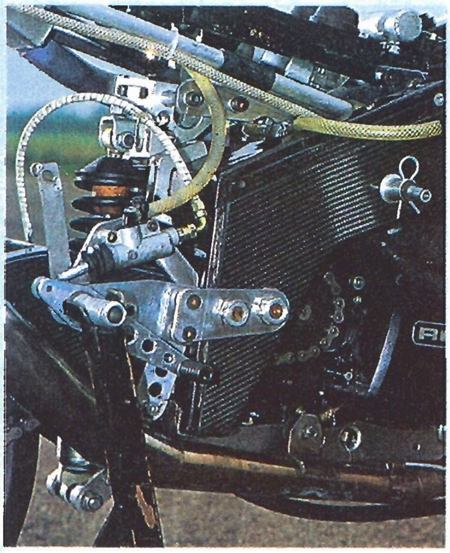
The Hejira frame is neat enough and, more important, the riders like it. From a retail point of view, there is a lot to be said for not straying too far from metallic designs... it means that most parts are compatible between the two, so the same cycle parts, suspension, wheels and brakes can be used on the steel or the carbon versions.

As far as reliability is concerned the carbon bike did the whole of last season with just one failure, a water pipe broke at the pump and was cured by altering the mounting. As the single cylinder Rotax is probably not the kindest of engines to any chassis, this is impressive enough. Surprisingly, the lighter chassis doesn't vibrate as much as the earlier steel frame.

Although the development was done with the Rotax engine, the frame was designed to accept any of the singles, 250GP engines, the Norton Wankel and possibly the 888 Ducati. Another frame for racing 125s is under way.

The motor in the development bike is the twin-cam 605, complete with triple-plug head and twin 38mm Amal smoothbores. It is a few horsepower off the pace at the top of national competition which, when you think of it, isn't a bad way of proving a chassis... if any blitzing was done, it certainly wasn't due to an excess of power.

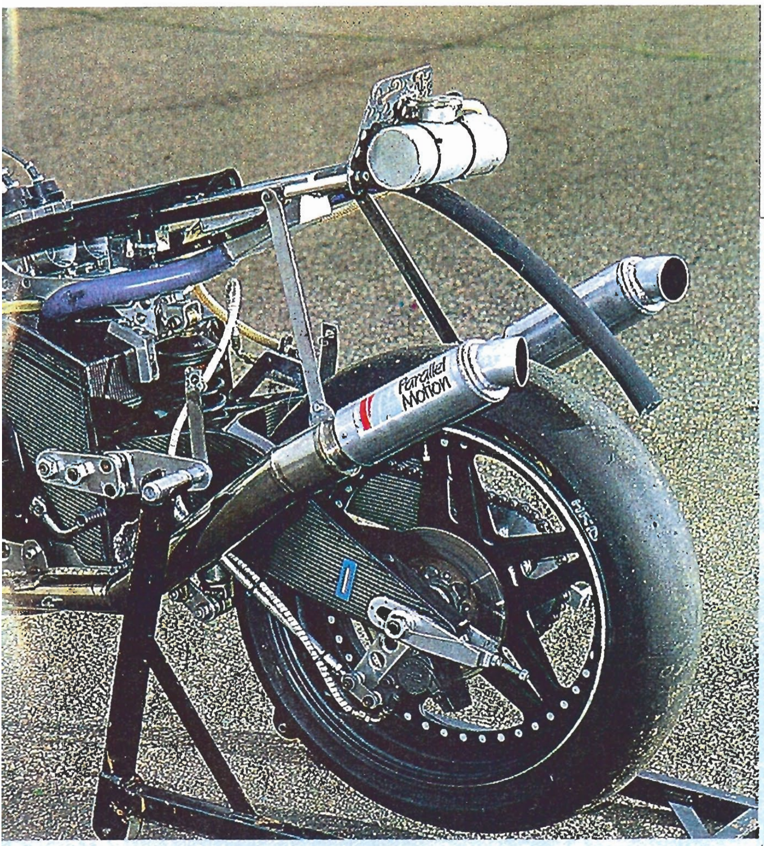
The main structural parts in carbon are the frame and swing arm. Other parts, like the fairing, tank and seat all contribute their bit in the lightness stakes but the wheels, brakes and forks



The Hejira frame and swing arm have alloy inserts bonded in at high stress points like the engine mounts.

Form and function chase one another in pleasing circles... a Kudos wheel.

Pics: Phil Masters, Alan Cathcart, Kenneth Pocho, John Robinson. Words: John Robinson

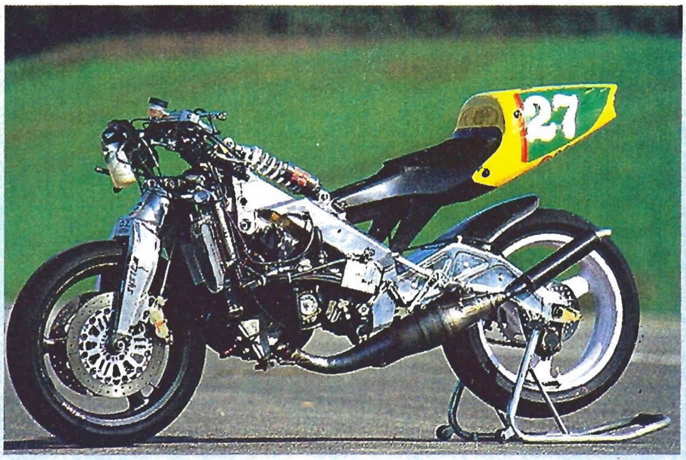


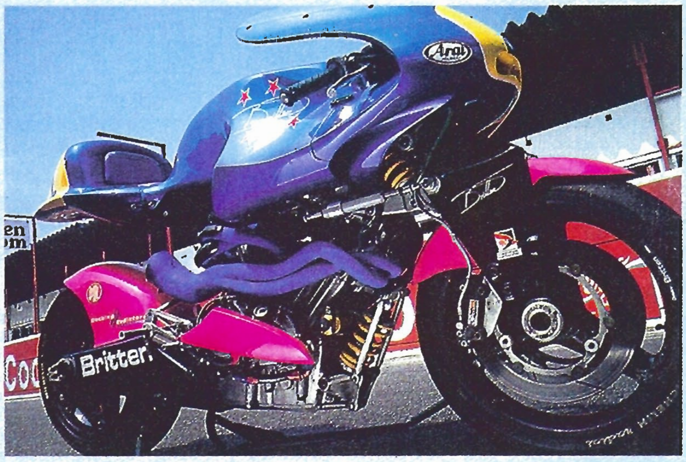
are all conventional. Astralite wheels, modified 38mm Marzocchi forks, and a mixture of Lockheed and Spondon calipers.

Of course, to liberate the full potential it would probably be necessary to use carbon-carbon brakes, as it would be to use carbon fibre wheels. The reason is that once you get the chassis as light as it could be with this material, it gets progressively harder to make the suspension work properly, unless the unsprung weight can be reduced in proportion. Iron discs and aluminium — even magnesium — wheels are a bit too archaic, I'm afraid.

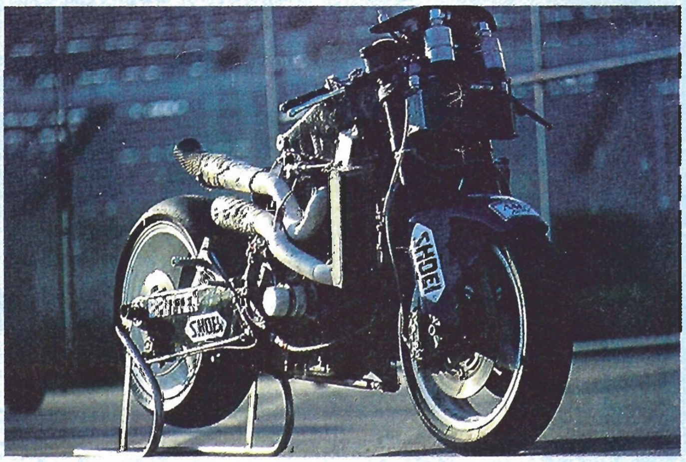
But going back to the original philosophy — if it is stiff enough and light enough, the geometry isn't critical — the Hejira chassis has the minimum amount of adjustment. The wheelbase and weight distribution are set up at the original mould stage (the box section is reinforced with honeycomb where necessary and alloy inserts are bonded in to take engine mountings and swing arm bearings). The steering head bearings are carried in eccentric cups, while the geometry can be fine tuned by playing with the front and rear ride heights. The rear unit is a Spax built to Hejira's specification and at the front the bike is set up to take either Marzocchi or WP upside-downers.

Even conventional front forks might have to go, though: the Britten has a very elegant double wishbone which incorporates large blade forks and this could easily be adapted to a design which is close to the Chittenden heart. His mudguards are already more aerodynamic than mud guarding; blending them into ultra-stiff, ultra-light fork legs would not create any philosophical problems, I suspect. He has actually gone a stage further with a hub-centre steered prototype but that is another story.





Above: unlike the editorial department (except Peter) the Hejira looks even better with its clothes off. And this is only the beginning, with wheels, brakes and front suspension still to come.
Top right: the easy option, followed by this OZ Aprilia and Norton, is to use carbon fibre sub-frames, bodywork and exhaust cans.
Middle right: the full Freddie; carbon fibre used to its maximum potential (so far) in Britten's frame, forks, swing arm, and wheels.



Above: the '91Britten used teles and considerably less sleekness. A year of development saw the double wishbone front end plus proper aerodynamics, with the coolers built under the seat and internak drag minimized.

A jolly useful carbon fibre shopping list, inc VAT

Chassis kit for 250 twins, unlimited singles: frame, swing arm, seat and fuel tank	£6462.50
Fairing	£352.50
Seat	£235.00
Front mudguard	£152.75
Rear mudguard	£152.75
Silencer tube, large	£117.50
small	£94.00
Kudos wheels (pair)	£2350.00

All carbon work and projects undertaken, from chassis to small components
Hejira Racing HRD, Manor Farm, Gawcott, Nr Buckingham, Bucks, MK18 4JF (telephone 0280 812152)