

On The Tools

TECH SERIES...
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ISSUE 4 **NUTS & BOLTS**
How to remove broken bolts & get the right torque settings.

Transmoto Expert



WHO DA DOLE?

Nick Dole owns and operates Sydney-based suspension business, Teknik Motorsport. In the past decade, the man has tuned suspension for the Ballard's Offroad team, performed engine and suspension work on Australian Safari-winning GHR Honda XR650s, run a Kawasaki Pro Lites team in the Aussie MX Nats, worked as an independent technical consultant for magazine test programs, and dealt with just about every punter and butchered dirt bike to ever roll into a workshop. We reckon that qualifies him to offer up credible advice about how to get the most out of your spend at the local workshop.

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The Nuts & Bolts of Nuts & Bolts

Fasteners keep your bike in one piece, so here's how to tighten, maintain, remove and repair them.

NICK DOLE IAN HANCOCK

The work of Mr Murphy – “if anything can go wrong, it will” – applies to the bolts, nuts and fasteners of your motorcycle. Easily overlooked, they wreck more rides and cause more race losses than any other mechanical DNF. Without fasteners, your bike would be a pile of parts on the floor.

While the topic of fasteners concerns all materials, most are metal bolts. There is an interesting field of quantum mechanics that could fit in here, but let's skip to the practical part, as there are a few characteristics of metal you need to know. Metal is a conductor of not

only electricity, but heat. Metals can bend a long way before they break. Metals are also elastic; when a load is applied, they can deform and return to their original shape unless their elastic limit has been reached. Lastly, they are strong, with characteristically high tensile strength.

Bolts have a tendency to come loose, seize, break and corrode if not maintained and cared for. So the following few pages will help you to keep that bucket of bits you call a motorcycle together without some of the pain your forebears experienced.

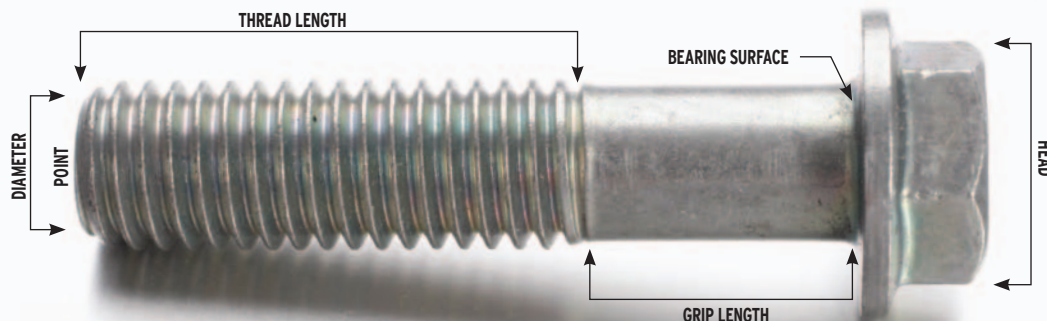
DEFINITIONS

LOAD is the overall force applied to a fastener or structure, whether resisting an externally applied force or supporting the weight of a mass.

STRESS is an applied force that can cause the deformation of a fastener.

STRAIN is the change in dimension of the fastener body as a result of stress.

STRENGTH is the ability to resist forces.



TORQUE SETTINGS

When you tighten a bolt, two forces are at work. Tension stress (stretching) occurs when the head of a bolt contacts the material it is to be tightened against. This form of stress – the use of the elasticity of the bolt – is what exerts a clamping force. A secondary shear (torsional) stress occurs as the friction from the threads and under the bolt head is overcome – a stress that is undesirable due to its inconsistent values – and is unavoidable.

This is where your torque wrench – used to achieve the correct torque setting – gets lost. It can't tell the difference

between tension stress and shear stress. Dirt, rust, plating, oil, anti-seize, Loctite and damaged threads will all have a big impact on torque readings, and therefore the bolt stretch you finally achieve.

How big is the impact? At worst, with dry and unplated threads, 50% of the torque applied to the bolt will be absorbed under the bolt head and 40% by friction on the threads, leaving only 10% to apply preloading to the bolt.

So what can be done to avoid this? There is not a lot of maintenance required on a bolt, but no threads work well when dirty or rusted, so keep

them clean. A wire wheel on a bench grinder does a great job of cleaning threads. While some light oil is okay as a lubricant, a zinc- or copper-based anti-seize is excellent for swingarm pivot bolts, chain adjusters and exhaust bolts. If you require retaining properties, use Loctite, which we will come to later.

Although using a torque wrench is necessary on critical bolts, for non-critical areas, feel is often the best judge; especially on older bolts. If you feel a bolt “give” while you are tightening it, replace it. ↘



REMOVING/BROKEN BOLTS

So the worst has happened – the bolt head has snapped off. If it's got a nut on the other side you can simply remove the broken part, but if it's in a part – and left a section of the bolt inside the thread – the problem is much more serious.

It's important to look at why the fastener failed for future reference. Was it overtightened? Was it loose and subjected to shear loads? Was the fastener the wrong type? In the vast majority of cases the bolt

will have stretched past its elastic limit on the last installation and broken on the narrowed 'waist'.

This is where the maintenance you have done previously kicks in. If the threads are clean and have either anti-seize or Loctite on them, it will be relatively easy to remove. If the bolt broke during installation due to high friction on the threads, you are in for some fun getting it out!



TOOLS



REPAIR METHODS

We have discussed helicoils and time serts elsewhere, but there are other methods. Lock serts and big serts are also options for when things gets ugly. For example, not drilling down the centre of a snapped off bolt means the drill drifts quickly into the soft aluminum, so a 6mm hole will soon become an 8mm. A big sert uses a 3/8 UNC 16 thread – that's close to 10mm – so you can 'fill the void' and save a disaster with a super strong repair.



ROUNDED HEADS

There are a few simple rules with all fasteners that will prevent rounded heads. Use the right size tool – this means no 7/16 spanners on 11mm bolt heads. Also select the correct type of tool (see 'Tool Selection' on the final page). The tool also needs to be square on the bolt or nut. A poorly held open-ended spanner is the cause of many wrecked bolt heads.

What to do if the bolt head is rounded? A single-hex socket will remove most damaged bolt heads. If this fails, the bolt is considered junk, so hammer an old single-hex socket onto the head. Another option is to weld a nut to the head. The heat from the welder pumped into the threads can help loosen it, too.



TORQUE WRENCHES

When using a torque wrench to reach the correct Nm setting, be careful to ensure you use the metric – as opposed to imperial – scale on the wrench. The bending beam-type wrench is reliable and accurate, as are the Australian-made Warren and Brown wrenches. Don't use socket extensions, as they can throw off the reading by twisting and absorbing some of the force. Creep up on the torque setting over four separate stages, and check the setting twice as the shear force will dissipate after a few seconds.



BROKEN-OFF HEADS



Broken-off heads are traditionally solved with an evil device called an 'Easy Out'. Anyone who has ever snapped one will know that there is nothing easy about drilling a broken, hardened Easy Out from a hole. It takes a cobalt drill or diamond-hard disintegrator, heaps of lubricant and some words your mother would rather not hear.

There is a better way. Drill into the centre of the broken bolt with

a left-handed drill, aiming right down the middle. In the process of drilling, you may very well spin the bolt out – as the drill is turning the bolt in an anti-clockwise direction, therefore loosening it – and it's job over! Start out small, be super accurate with finding the centre of the bolt and move up in drill sizes, always trying to shock the bolt out with sudden bursts of power. If this doesn't work, move to the next step.

STRIPPED THREADS



If the thread is butchered or you have drilled out a broken bolt with a left-handed bit to the extent that you are into the threads, an insert needs to be fitted into the hole to provide a solid, clean thread for the next bolt to go in. That is, unless you are a total Neanderthal and just tap a thread the next size up.

The traditional thread insert is a helicoil, but they are known to jump threads and lock onto bolts, winding themselves out. A much better

alternative is a 'time sert', which is not as well known. This solid-threaded insert – that is much the same as a helicoil to fit – is locked into the hole with a broach, and is much more sturdy. For other options, see the 'Tools' sidebar.

Whichever method you choose, get it straight and pay attention to the drilling size suggested in the tap. And, if you're out of your depth, find someone who knows what they are doing.

TAPS & DIES

It is handy to have a collection of taps and dies in your workshop, as rusted or dirty threads are always a problem on a dirt bike. There are only a few main sizes you need for most jobs. A handy selection is 6x1.0mm, 8x1.25mm and 5x0.8mm. Buy good quality tools, like Aussie-made Suttons, as a cheap tap can do more harm than good. When chasing out a thread, if you start to remove metal, stop and check the size. And if the thread is deformed on the male or female thread you are chasing, replace it.

LOOSENING



As we've explained, it's mostly the tension created by the elasticity in a bolt that keeps it tight. This produces a dilemma for many fasteners on a dirt bike, as they are not pulled up against hard surfaces. Plastic, with its low tensile strength, will deform, causing the fastener to loosen. This is why the alloy or steel inserts in your shrouds, guards and seat perform a crucial role in keeping the bolt tight. It's amazing how some manufacturers

ignore this fundamental principle and use plastic as a loaded part. The Euros have been onto a good concept for a while, using no inserts in the tank and a coarse thread bolt straight into the plastic. It looks rough at first, but works well as there is next to no load on the radiator shrouds. Through vibration and repeated stress – whatever the material – some bolts will work themselves loose, so here are the main methods of keeping things tight.

LOCTITE

For keeping most fasteners tight, it's best to use an anaerobic (cures in the absence of air) liquid thread retainer, such as Loctite. A drop of the right grade applied to the tip is all you need to keep a bolt – correctly tightened – in place. Oil and dirt will lessen the effectiveness of any anaerobic retainer, so you still have to clean the threads before applying it. A squirt of brake-clean from an

aerosol can does a good initial clean, but there are Loctite primers in aerosol cans if you're a perfectionist. As per the guide below, there are different grades of anaerobic retainer, and using the wrong product can be disastrous. Ever tried to remove a bolt that was primed and coated with permanent assembly Loctite? It's strong enough to cause a bolt head to snap or make tank inserts spin.



LOCTITE GRADE GUIDE

222

Low strength. Designed for fasteners that come apart often, such as radiator shrouds and guards. It won't hold bolts so tight you need heat for disassembly, but it will stop corrosion and lost parts.

243

For general-purpose use. It can still be disassembled with hand tools and – like all Loctite – will virtually eliminate galvanic corrosion between steel and aluminum.

263

For permanent assembly. Will require a heat gun and 400 degrees plus for it to break loose. Use it on the axle feet of lower fork tubes and shock yoke shafts.

290

For use when disassembly is not required! Great for spoke nipples, as it allows you to tighten them up, but stops them from loosening. It also prevents corrosion.

BOLT TECH

Inspired by the nautilus shell, threads have been with us since ancient Greece, so say thanks to Archimedes from 200BC. Then after WWII, the thread angle was standardised to 60 degrees, as the USA, Europe and the UK were all on different standards. This became uniform in both metric and imperial standards. The main difference between a metric and imperial thread system is the description for thread pitch. Metric thread pitch is measured in mm (1.0, 1.25 and 1.5mm are common), and imperial threads are measured in threads per inch.

Australia has adopted the international ISO bolt standards into the Australian Standards. However, most bolts sold at the hardware store are cheapies that do not comply, so avoid them like the plague. If buying bolts from a fastener retailer such as Blackwoods or Coventry, request a Letter of Conformance to ensure the bolts you are using comply.

Also, critical triple clamp/handlebar/axle bolts are designed for a specific purpose, so it's worth the measly extra cost of buying genuine fasteners when you consider the cost of it failing.

Finally, bolts are tested for tension (stretching) strength and hardness. One critical point to remember is that 'stiff does not imply strong'. For example, a bolt made of glass would be very stiff, but could not stand any impact load – it is not strong. Using that theory, different grades of bolts have different tension, compression and shear properties, and bike manufacturers use different grade bolts for different purposes. Therefore, it is important to use the correct grade when replacing a bolt. Metric fasteners are stamped with their grade, either 4.6, 8.8, 10.9 or 12.9, from weakest to strongest. Also, bolts in critical applications should be replaced periodically. 📌

LOCKWIRE



Lockwire is not just for grips, but can be used on footpegs and to mechanically keep bolts tight. While it comes in sizes 0.020" through to 0.040", the 0.032" in 302-grade stainless steel will do everything you need on a dirt bike. A 1lb tin of it should last you 10 years, and the fancy wire-twisting pliers are not necessary if you follow some basics.

Cut the wire long enough to do the job, and use smooth-face pliers for twisting. Pull on the wire while twisting to take up the slack, but don't make it tight. Don't nick the wire with pliers, as increased stress will cause it to break. And remember to pick up the little off-cuts, as they are sharp and can be disastrous if sucked into an engine.

LOCK NUTS



Spring (lock) washers have no place on a motorcycle. Why? Try compressing one with your finger. By the time the bolt has backed itself out enough for the spring lock washer to be effective, the bolt is loose and on the way to falling out.

Instead, put a flat washer under the bolt with Loctite. Also, integrated flange-type bolts are

now commonplace on motorcycles, and don't need a washer. 'Nyloc' or 'conelock' nuts are great for reducing the chance of loosening, but should be replaced after every couple uses.

Folding tab washers should be avoided if possible. In order to be able to bend the tab over, the washer must be relatively soft and susceptible to cyclic stress, and can squeeze out

OTHER ESSENTIALS



CABLE TIES



What did we do before cable ties? String? An aircraft spin-off from the mid-'50s, cable ties are great for holding things in place. As there are no strict SAE manufacturing standards, it's best to go for a brand name like Ty-Rap if the job is critical, as cheapies can skip teeth and crack. And if the cable tie

breaking is going to cause personal injury, it's not the right application for a cable tie. There are tensile strength ratings, but UV rays really hurt nylon, so it's better to use them under tanks and seats where they don't get direct sunlight. Instead, hose-clamps can be used in these applications.

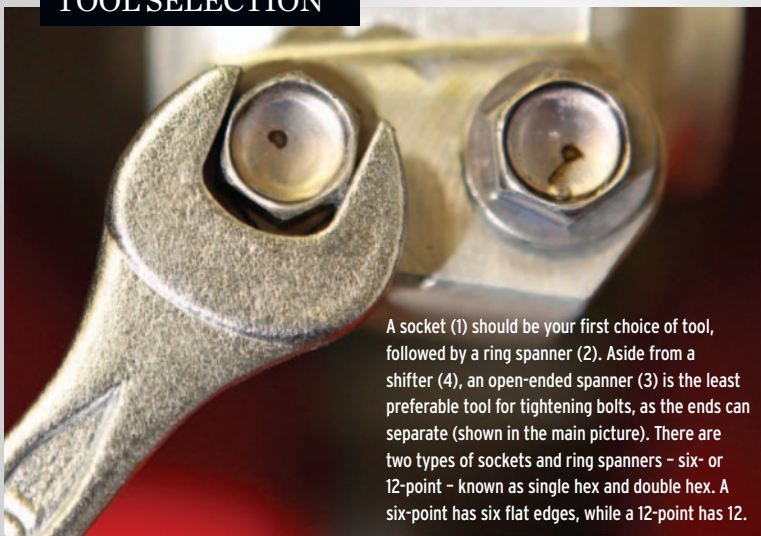
ADHESIVES



People use all sorts of adhesives on their grips, from hairspray, paint, araldite, grip glue, contact cement and gorilla glue. Contact adhesive in an aerosol can is usually the most convenient and effective. If you are a real grip-destroying gorilla, 5 Minute Araldite is good, too, but when finished you need to cut the grips off

like peeling a banana. Anything that dissolves in water - such as hairspray - is no good; two throttles aren't cool. The only other adhesive in your toolbox should be white ThreeBond liquid gasket cement. It's also sold as an OEM sealant, and it's the only one worth having. Use it sparingly, like any gasket cement.

TOOL SELECTION



A socket (1) should be your first choice of tool, followed by a ring spanner (2). Aside from a shifter (4), an open-ended spanner (3) is the least preferable tool for tightening bolts, as the ends can separate (shown in the main picture). There are two types of sockets and ring spanners - six- or 12-point - known as single hex and double hex. A six-point has six flat edges, while a 12-point has 12.



AFTERMARKET



For non-critical applications such as tank and seat bolts, there are a few companies selling bolt kits with the type of flange-head bolts that don't require a washer. The quality can be good or bad - you will know the first time you tighten one. A good bumbag assortment for Japanese bikes is a collection of 6x20mm, 8x30mm and 5x40mm bolts. A gear lever bolt and a top shock bolt are also required for KTMs. However, a better plan is to spend some shed-time before you leave home, so you don't waste time working on your bike when you could be riding. 🏍️

BOLT STRETCH

As you can see in the picture, the bolt in the foreground is deformed and is skinny through a section of the thread length. This was caused by the bolt being stretched past its elastic limit. It can no longer function properly, and needs to be replaced. The bolt at the rear is straight, and therefore hasn't been stretched past its elastic limit.

