

Bolts and pins brave tough environments

Tom Shelley reports on developments in fasteners for wind turbines, construction equipment and other demanding outdoor applications.

Bolts and other fasteners in an outdoor environment – particularly when subject to salt spray – are in danger of failing through cracking, but it is now possible to find surface treatments that are at least as good as cadmium, now banned except for use in aerospace, mining, nuclear and offshore. This is despite the fact that the vast majority of cadmium is used not for coating, but in nickel cadmium batteries, which mostly end up in the environment despite all efforts, legislation and good intentions.

Zinc flakes and related sub melting point processes involving aluminium zinc alloys, now seem to be the coatings of choice for really demanding applications. Near shore wind turbines bolts provide a particular challenge.

In addition, special fasteners are constantly being developed for special applications. One of the latest to reach our attention is a special pin for preventing the formation of oval holes.

If corrosion on its own were not enough, bolts pose two additional problems. The first is that the bases of the screw threads offer obvious sites for cracks to start, and provided they have been properly torqued up, are under tension. This makes them prone to two related hazards: stress corrosion cracking and corrosion fatigue. In both cases, the process is accentuated because the



tip of the opening crack becomes a preferred site for corrosion, forming the positive electrode of an galvanic cell, with the rest of the surface forming the negative electrode.

The solution is to have a sacrificial coating which corrodes in preference to iron, and produces corrosion products that will hopefully clog up the galvanic cell and prevent it operating.

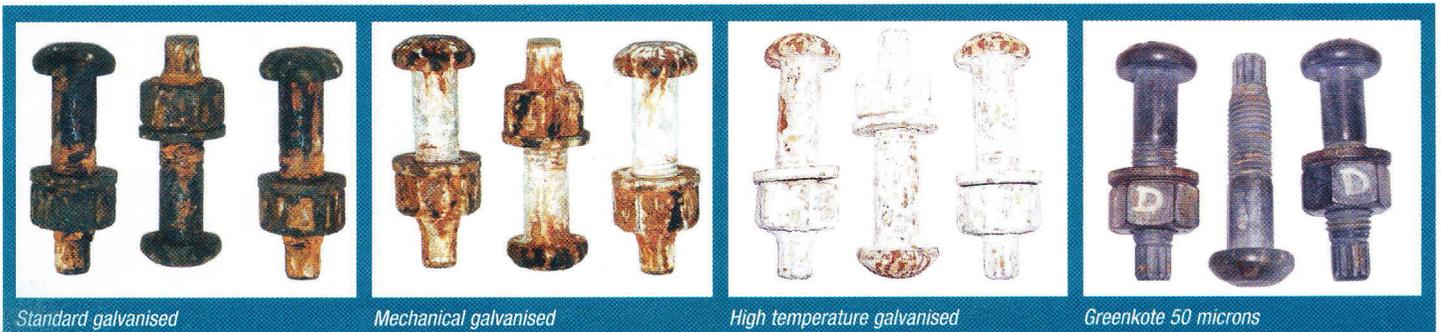
Cadmium is perfect, apart from its price, but concerns about its toxicity mean that its use is now strongly discouraged except where nothing else will do, so users have to turn to zinc, or one of its alloys. The traditional way of applying zinc is either to use electroplating dip steel parts in

the molten metal, which has long been the traditional approach for protecting bolts in electricity transmission towers, for example.

The problem with depositing zinc by electroplating is the possibility of hydrogen embrittlement resulting from the acid pickling process that precedes the plating. The problem with hot dip galvanizing, on the other hand, is the formation of brittle zinc-iron intermetallic compounds in the surface layers. There is insufficient time for this process to penetrate deeply into the underlying metal, but it does mean that overall design strength is slightly lower than it would be if no intermetallics were present.

The solution, which is available in different forms from a number of companies is to diffusion bond zinc or zinc alloy flakes or particles to the underlying metal at temperatures below the melting point.

At the Hannover Fair, the German company Dörken was promoting its Delta MKS process, the letters standing for: Mikroschicht Korrosionsschutz System. Licensed all over the world, the process involves the deposition of a base coat and a top coat. Jörn Selent, responsible for marketing told us that the base coat consists of zinc flakes in an inorganic





matrix. This can be laid down by spraying, spin coating, dip and spin or dip and drain. Curing is by heating to around 200°C to 240°C for 20 minutes. This contrasts with the 445°C to 470°C required for standard hot dip galvanising and the 530°C to 560°C required for high temperature hot dip galvanising. The base coat may be followed by an organic top coat to give a coloured finish or provide lubrication properties.

On a neighbouring stand, the French company NOF Metal Coatings Europe was also offering a zinc flake process under the 'Geomet' brand name, which sounded vaguely similar, although we did not manage to elucidate details. In their case, the top coats are black, 'Geoblack' and strongly targeted at the automotive market, although wind turbine bolts are included in their list of applications.

In the UK, TCB - Tension Control Bolts - in Whitchurch, Shropshire, has its own process 'Greenkote' whose ingredients sales engineer Gary Mason described to us as "Aluminium, zinc, and 3% Magic X factor". The process consists of placing bolts and metal powder, plus the secret ingredient, in large rotating retorts at 420°C. It is thus related to the long-established process of Sherardizing, in which articles are heated in the presence of zinc dust. The latter process is normally carried out in a slowly rotating closed container at temperatures ranging from 320°C to 500°C.

Greenkote is more than this, because the coated items do not have to be acid etched prior to being painted, and do not have to be lubricated. Cost is very similar to that of hot dip

The 'Expander' is used in a variety of arduous environments



galvanising but the results are a lot better. In salt spray tests, Greenkote coated bolts outperform all other types of hot dip galvanised bolts by a margin.

The bolts themselves are key to a proprietary technology in which the bolt shanks extend past the nuts into a splined section. Nuts are tightened by a special shear wrench which fits over the bolt spline while the outer socket fits over the nut. On pressing the trigger switch, the outer socket rotates clockwise and tightens the nut. When the correct preload is reached, the outer socket stops rotating, the inner socket counter rotates and the spline is sheared off at a break neck. The wrench is stopped and the outer socket pulled off the nut. The spline is retained in the inner socket and may be ejected subsequently.

The problem of pins producing elongated holes in moving joints may be addressed by a Swedish invention that has been used for decades in Scandinavia, but has only just been taken on board by a UK company, Midland Steel Traders in Birtley, County Durham.

Once pivot pins start to become loose, their movement has a strong tendency to increase the hole widening process until it becomes oval,

requiring re-boring of the parts that the pin connects and the fitting of a larger pin, or even the complete replacement of the linked parts. The solution offered by the 'Expander' is to have sleeves which are pressed onto tapered sections of the pin at each end by tightening up a nut and washer arrangement. This eliminates all play in a few moments. The devices typically cost around twice as much as a traditional pin, but users of equipment used in arduous environments reckon they soon recover the additional cost.

The pins are fitted to Volvo loaders and forestry machines and Doosan excavators.

Their main use, however, is in the aftermarket, where repairers in Sweden and elsewhere have long used them to replace traditional pins in worn mountings in excavators and other items of construction equipment and even in lifting bridges. A typical application is by Motala Verkstad in a lifting railway bridge over the Göta Canal in Norsholm, where the pins were used to solve a wear problem in the mountings of the main lift cylinders.

- www.doerken-mks.com
- www.nofmetalcoatings.com
- www.tcbolts.com
- www.sherardizing.com
- www.expander.se
- www.mstracks.com

DESIGN POINTERS

- Now that cadmium plating is not allowed to be used in many arduous applications, including some subject to salt spray, zinc flakes applied in an inorganic matrix offer a solution. Curing at around 200°C is well below the melting temperature of zinc and avoids possible formation of intermetallics
- A UK process called 'Greenkote' which appears to be developed on from Sherardizing also shows very good results, creating diffusion bonded coatings of zinc - aluminium plus proprietary ingredients that ease painting and provide lubrication
- Swedish expanding pins, long used in Scandinavia but new to the UK offer a solution to worn holes in pivot mountings