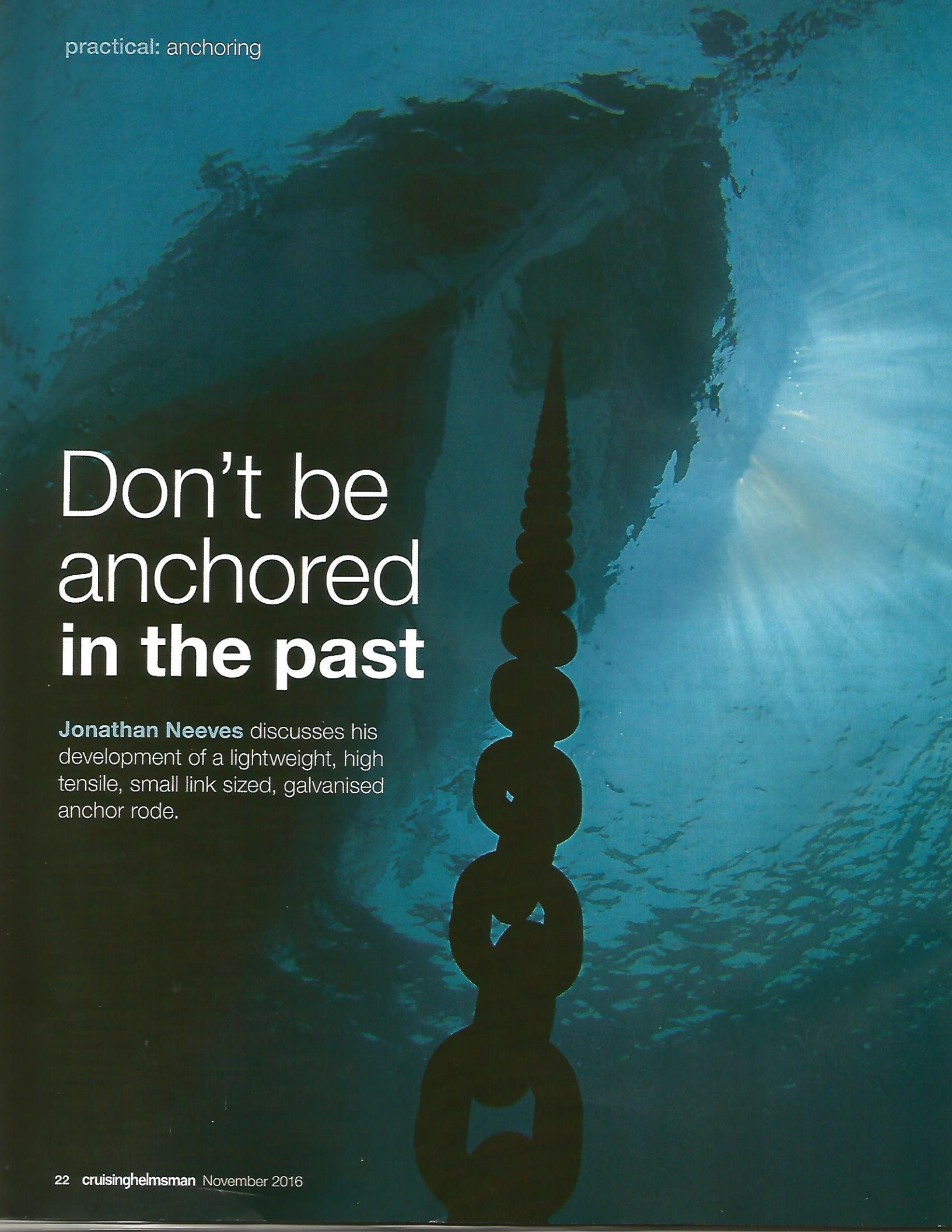


Don't be anchored **in the past**

Jonathan Neeves discusses his development of a lightweight, high tensile, small link sized, galvanised anchor rode.

Electronics' developments are now so fast that buy a bit of kit today and in six months time it has been replaced by something factorially better and sometimes cheaper.

Buy a new sail, new piece of high tensile cordage or even a new yacht and in no time at all that investment is 'yesterday's hero'.

You could have bought a state of the art anchor five years ago and find a better one today. If you want real stability and be certain you will not be overtaken by technology: buy anchor chain!

Arguably, chain has improved. It is now of a reliable and predictable size and it is made to a strength specification, but otherwise anchor chain today is the same as it was decades ago. But behind the scenes there are changes, they might not take root but if they flourish the changes will shake inherent beliefs and maybe the industry, to the seabed.

Now and the future

The changes are underpinned by two factors: catenary is largely a confidence trick or for Luddites and high tensile steel chain is freely available.

Let us look at the second change first.

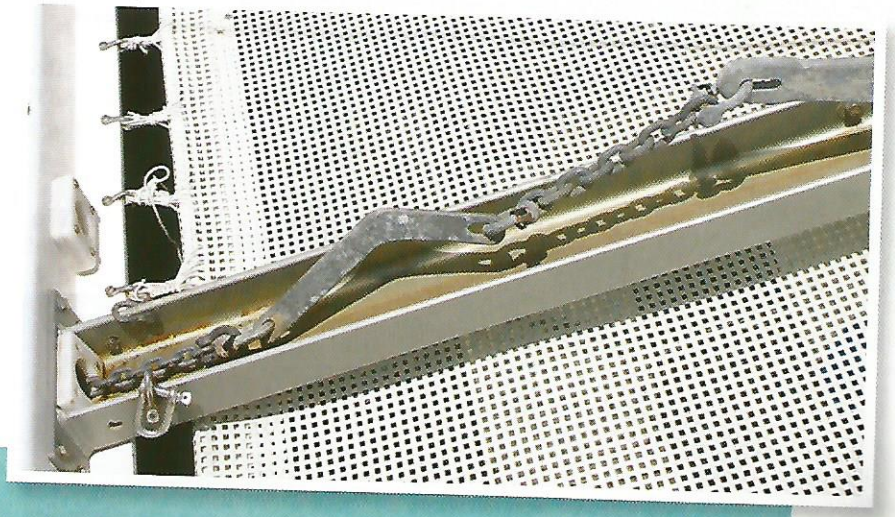
Most people will remember the furore over the use of Bisplate 80 in the shank of some anchors. Regular cruisers will also know that anchors made with mild steel shanks can be prone to bending, so the concerns had foundation.

Bis 80 is an Australian made steel with high tensile (HT) strength but it is not unique and the same quality is freely available world wide. Whereas this sort of steel came to the forefront of the leisure marine industry around a decade ago, similar qualities have been available for much longer and have been used in the lifting industry to make lifting chain.

Strength is imparted two ways: through careful choice of steel chemistry and from downstream processing. Many of these high tensile steels are quench and tempered (Q&T). Basically the steels are heated to a red heat, quenched with water or oil, which destroys their crystalline structure, reheated and finally cooled (tempered) under strictly controlled conditions.

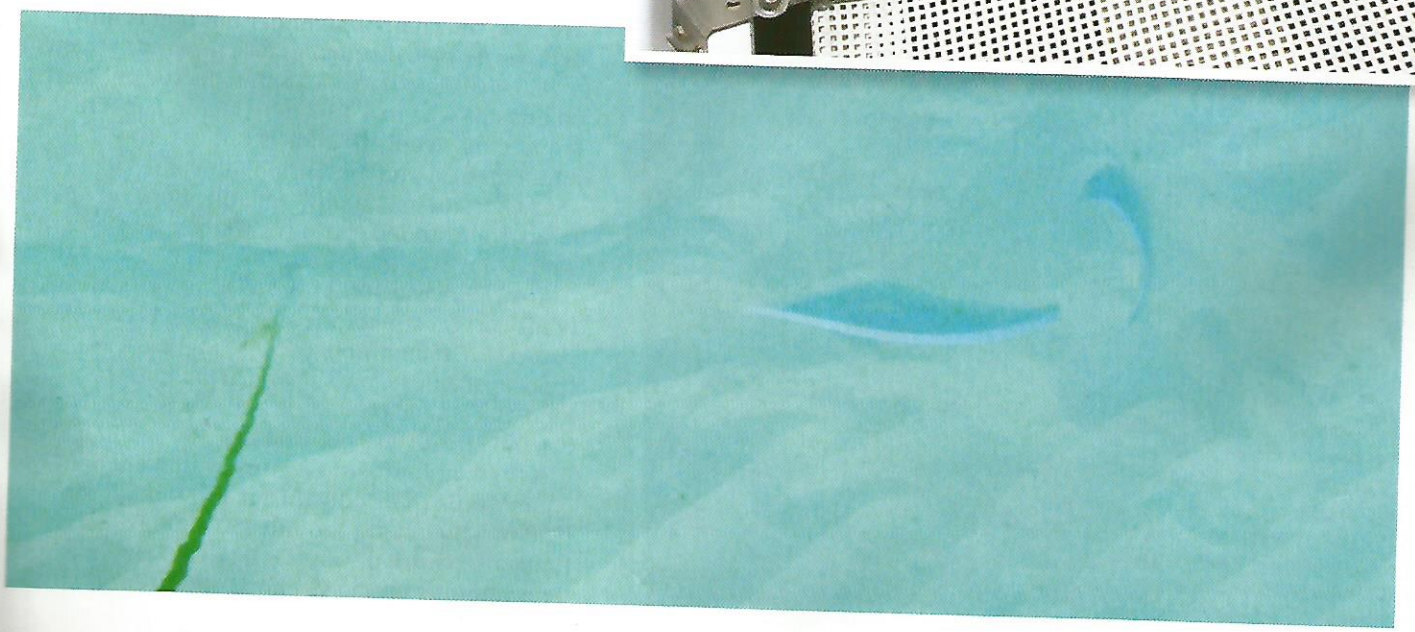
The cooling schedule imparts a new and strong crystalline structure. Lower strength HT steels are tempered at higher temperatures than higher strength HT steels. Typically a 700 MegaPascal steel might be tempered at 450 degrees Celsius; a 1,200MPa steel might be tempered at 250°C.

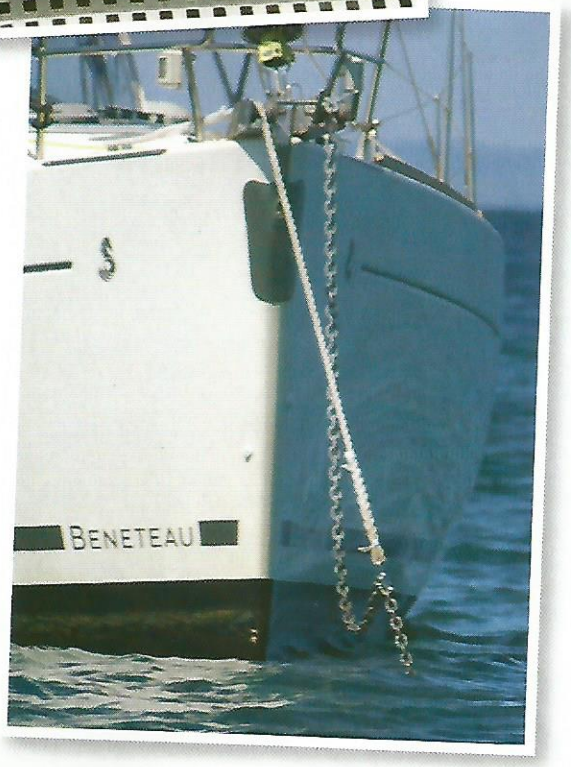
The temperatures, chemistry and cooling schedules are closely guarded proprietary information and vary from manufacturer to manufacturer. We all know of HT steel's application in the shanks of anchors, but more common applications are found in the mining industry where high tensile steels are used for the abrasion resistance.



BOTTOM: An almost fully set alloy Spade.

BELOW: *Josepheline's* current 6mm rode with boomerang.





TOP: Strength testing of the Gunnebo original, supplied painted yellow, 6mm x G80 chain, before Armorgalv coating.

ABOVE: Armorgalv coated 6mm x G80 chain with G80 Omega Link and 3/8th" Armorgalv coated shackle attached to 15kg Excel anchor.

RIGHT: A short snubber offers no elasticity, it takes the load off the windlass and stops the chain rattling on the bow roller but needs to be stronger than the chain as both the chain and snubber take the same load.

High tensile steels are also used by defence forces for armour plating and to build the Collins class submarine. Closer to home HT steels are used in the keels of some high performance yachts, as the fin can be much thinner if made from HT steel.

But to return to chain. Anchor chain in Australia is now almost exclusively Grade L, the wire from which the links are made are of a minimum strength of 300MPa: a mild steel.

"So, if catenary has disappeared just when you start to really need it at 30 knots why carry all that weight in the bow?"

Internationally, this chain would be defined as a Grade 30, or G3. Why Australia calls it Grade L is odd. Commonly the steel used is actually a bit stronger than this, around 350MPa.

There is also a Grade 40 becoming more common in Europe and a Grade 43 in America. G43 is also known as HT, as in high test not high tensile. G43 is a transport chain, used in trucks, say for securing logs in the forestry industry. A similar wire is used to make a G70 transport grade, which is effectively a Q&T version of a G43 as it has slightly different chemistry.

The numbers reflect the chain strength in ratios of: 3:4:4.3:7. So G7 is 7/3 (seven divided by three or 2.33 times) stronger than G3.

Except it is not quite that simple! Although metric chain is made in regular millimetre increments, 6mm, 8mm, 10mm etc.; imperial chain is made as 1/4", 5/16th", 3/8". These imperial sizes are nominal and a 5/16", which is almost 8mm, can be actually closer to 9mm.

So imperial chains can 'look' better than they are. Yes, the chain is stronger but that is only because it's heavier; not because the steel is 'better'.

G43 is also sold to a 3:1 safety factor but metric chains are sold to a 4:1 safety factor, superficially enhancing strength further. But it is all a mathematical and marketing, illusion.

Anchor chain is highly reliable. Reports of failure of branded chain correctly specified are simply not available.

Australia's use of G30, or in Ozspeak – Grade L, of the correct size for the size of yacht is completely successful. If anything, because there are no reports of failure, the safety margin must be as high as it should be as well. Your yacht and its crew depend on, not 99.9 per cent but, 100% reliability.

A further confusing feature is that anchor chain needs to be galvanised and though the heat of galvanising around 450/460°C does not impact strength of G30, G40 or G43 chain, it does impinge on the strength of G70 chain.

G70 chain is a Q&T chain and the galvanising temperature and tempering temperatures are so similar that there can be marked degradation of strength, by up to 25%, as a result of the galvanising process. So a galvanised G70 can effectively be a nominal G52.5 strength.

Chain makers have a variety of techniques to keep the end result, the final strength, of the galvanised G70 quality as close to the original strength as possible. We suspect some chain is actually made from a base steel allowing higher strength before galvanising, than the 700MPa.

Australia manufactures a Grade P, which is a Q&T chain equivalent to a G50. This chain is sometimes available as a stainless grade, used in the food or chemical industry as a lifting chain.

But there are now other qualities of chain available namely: G80, known as Grade T in Australia; G100 and G120. Basically a G120 chain is four times the strength of a G30 chain.

These newer chains are all Q&T. G80 is now almost a commodity product as opposed to a specialist product. Especially as China can make perfectly acceptable quality and some manufacturers of chain have simply moved out and up and restrict their portfolio to G100 and G120 chain with a whole range of components. Technology in China is moving very quickly, it is already possible to buy Chinese G120.

Why is any of this important?

A G30 chain of twelve millimetre has a strength at break of seven ton and a weight of 3.3 kilograms per metre. The nearest-strength galvanised G70 chain would be 8mm with a strength at break of 7t and a weight of 1.4kg/m.
A 10mm G70 would be 2.35kg/m and 11t break.

But a 6mm G120 chain, ungalvanised, has a strength of 7.2t and a weight of only 1kg/m. If you carried 50 metre of chain in your bow locker then the 12mm x G30 chain will weigh 165kg, the 8mm x G70, 70kg and the 6mm x G120 a paltry 50kg.

The windlass you would need for the 6mm G80 would be lighter, smaller and cheaper, the wiring would be downsized and the power requirement for the windlass, again, smaller. You would need less reinforcing in the bow to secure the windlass. Arguably you could lift the G120 ground tackle by hand. You could have a larger forepeak because the anchor locker could be much smaller.

The reality is, lets get our feet back on the ground, that it is not yet proven that G100 nor G120 can be galvanised commercially but G70 is already regularly galvanised and G80 is 'almost' a sensible commercial and technical proposition in a galvanised form.

Galvanised G70 is a common quality in America, has recently been introduced to Europe and is made to a size to match the gypsy of a standard commercial leisure windlass. G70 is galvanised by both Peerless in America and Maggi in Italy and the latter is available in New Zealand via Chains Ropes and Anchors.

Both Peerless and Maggi make imperial and metric sizing. For metric sizes the smallest currently available is 8mm; 10mm and 12mm are also made.

G80 lifting chain is a common quality now, it has been used for decades. It is made to link sizes that fit common gypsies such as Muir and Maxwell and probably others. It is freely available from both Europe and China. Chinese quality, we suspect from specific suppliers, is accepted widely in the lifting industry in Australia. Advantageously, it is possible to source 6mm x G80. G80 is not available galvanised w– but read on.

But the big question that has been at the forefront of your mind since you started reading: what is this about "catenary being a con?" Surely everyone knows you need weight in the anchor chain to dampen and counterbalance strong wind gusts.

HYDROGEN EMBRITTLEMENT

The big monster overlooking the use of high tensile chain in the anchor rode is the threat of hydrogen embrittlement (HE). Speak to any armchair expert and HE will raise its ugly head.

It is very real, though not in this situation.

There are many causes of HE. The primary and most well known mechanism is the migration, at an atomic scale, of hydrogen atoms from the surface of the steel. The hydrogen atoms congregate at micropores, form gaseous hydrogen which results in increased internal pressure resulting in cracks and eventually catastrophic failure.

It has occurred in Australia, a famous bridge failure in Melbourne and more recently a bridge construction delay in San Francisco.

The mechanism is particular to low ductility steels particularly those steels acid washed prior to galvanising. Armorgalv involves no acid washing and the resultant product is exceptionally ductile.

Heavy anchor chain, catenary and all it implies is really a hang over from old fashioned anchors. The anchors were not very efficient so having heavy chain and a lot of it improved anchor performance. In fact some of the anchor's 'hold' was derived from the chain, not the anchor.

We now have anchors that are, inarguably, twice as good as the traditional designs; are largely reliable, except in some questionable seabeds and work well at short scope. If these modern anchors work well at short scope, see Dashew's usage below, why would you need a heavy anchor chain? Basically, catenary was valid 50 years ago but, just like electronics, chain technology and potential application has moved on, even if ideas have not.

ARMORGALV

Zinc metal is unusual in that it can sublimate, pass from a solid form to a vapour form without melting.

If you want an analogy think of dry ice, it passes from a solid (ice) to a gas without passing through a liquid phase. Zinc metal is exactly the same but at a more elevated temperature.

This rather unique property was the basis for Sheradizing, invented in 1900. An update of the process is called thermal diffusion galvanising (TDG) or the Armorgalv process.

Basically, you heat zinc dust in a sealed container with some catalytic additives. The zinc vaporises and condenses, desublimates onto the surface of objects in the container at temperatures below the melting point of zinc. The process is normally conducted at 400°C. Hot dipped galvanising (HDG) is usually conducted at 450/460°C.

The Armorgalv process can be conducted at lower temperatures, it is suggested at as low as 250°C, but lower temperatures demand longer process times. Because the process is gaseous it is particularly adaptable to galvanise intricate and/or hollow objects.

The Amorgalv process has another advantage: the products of the process, Fe/Zn alloys, are harder, more abrasion resistant than the alloy products of HDG.

Unfortunately most galvanising, from either process, is for corrosion resistance. Anchor chain needs abrasion resistance and corrosion resistance. Historically, in the absence of more informed requirement, the coating of chain with Armorgalv has followed industry standards which have been too thin and the coating has enjoyed accelerated wear. By comparing abrasion resistance using a simple and cheap test and comparing with the best HDG chain coating available it has been possible to better define sensible coating thicknesses.

There is no doubt the development can be improved, it is not rocket science.

Prove the theory

We conducted two experiments. We took 30m of 8mm chain and deployed it at a 5:1 scope and tensioned the chain such that the lowest link was just kissing the ground, so basically every link was off the seabed. The tension in the chain was about 70kg. This is equivalent to the load on a 45' yacht in around 17 knots. At wind speeds over 17 knots all the chain, 8mm, with 30m deployed would be off the seabed at a 5:1 scope.

The other experiment, very subjective, is that at the same scope, same yacht, same chain the chain appears almost straight at 30 knots and above. There is some sag, some catenary but basically at 30 knots the 45' yacht at 5:1 scope on 8mm chain, is connected to its anchor by an almost straight, inelastic piece of articulated steel. Whatever catenary is left is of no real benefit.

If you do not believe any of this, take 20m of 8mm chain, get two strong, fit young men, one at each end and have them pull the chain as tight as possible; then get another young man to add a sharp tug at one end. The catenary will do little to reduce that tug for the single person, it is just an articulated length of steel, offering no elasticity, no dampening effect.

So, if catenary has disappeared just when you start to really need it at 30 knots why carry all that weight in the bow? Basically if you could have high tensile piano wire it would be just as effective.

We conducted another simple experiment. We took an anchor and set it with 12mm chain plus, separately, with 6mm stainless wire. Then set the same anchor, the same load, same length of rode, same seabed, same depth, same yacht.

The wire rode anchor set 25% more deeply than the chain set anchor. Very crudely, a decrease in chain size by 2mm, so 12mm to 10mm for example, will result in a 6% improvement in set or hold. Basically, the bigger the surface area of the rode, swivel and chain, the less deep your anchor will set i.e. the lower its holding capacity. Piano wire is starting to look interesting!

For metric chain if you were to upgrade from G30 or G40 to a G70 or G80 you would simply reduce one size, go from 12mm to 10mm, 10mm to 8mm and 8mm to 6mm (but only to G80 as there is no 6mm G70). There would be no sacrifice of strength but the advantage of the 'thinner' rode will obviously, in terms of setting depth, be small, that 6%.

But is this all 'airy fairy', 'pie in the sky' nonsense?

Steve Dashew, you need to look him up (www.setsail.com), has been using G70 smaller link chain for decades, going from 12mm G30 to 10mm G70. Initially on his sailboats but more recently on his larger motor yachts.

He sells his motor boats to intelligent, normal people with the same small link and 'catenary is a con' philosophy. Read forum threads and an increasing number, but still a minority, have been convinced, G70is used and so far there have been no horror stories. There appears to be a groundswell of support.

"Heavy anchor chain, catenary and all it implies is really a hang over from old fashioned anchors."

It merits mention that Dashew's philosophy extends to his anchor, his comment is "if no-one laughs at how big your anchor is, it's too small!" He is very much a proponent of 'bigger is better'.

Dashew used to use large, genuine Bruce anchors, moved allegiance to Rocna and most recently is now installing large Manson Supremes. Part of his reasoning, as described here, is that modern anchors are better and his anchors, being oversized, allow him to anchor at short scope, in anchorages that would otherwise be inaccessible.

But, there is always a but, galvanised G70 is only available here from America or Italy, neither are renowned for being cheap production bases and international freight of chain is obviously expensive. The other downside is, if you like the idea and are downsizing then you will downsize from 12mm to 10mm or 10mm to 8mm saving 1kg/m; or 8mm to 6mm saving 0.6kg/m, so now you will need a new gypsy costing AU$300 or more.

My partner and I are converts, we believe in the small, but strong, chain philosophy and have invested in our beliefs. This is our story.

The yacht and its anchors

We sail a Lightwave 10.5, *Josepheline*, which we have extended to 38'. In full cruising mode it weights around 7t. For comparison, we estimate a 38' Lightwave has the approximate windage of a 2010 Bavaria 45 or equivalent.

We try to cruise, when pressures allow, Tasmania's west coast. We do not believe in 'bigger is better' for anchors and carry a 15kg steel Anchor Right Excel; backed up with an 8kg alloy Excel, an 8kg alloy Spade A80 (same size as 15kg steel Spade) and 8kg alloy Fortress FX23.

OPPOSITE PAGE; LEFT TO RIGHT: Measuring galvanising thickness in microns of the ground links of the Armorgalv coated 6mm G80 using a magnetic coating thickness metre.

The 2 x 20l pails on the left contain a combined 50m of 8mm chain, the 20l pail top right contains 50m of 6mm chain – there is a considerable saving in space to downsize from 8mm to 6mm.

"High tensile steels are also used by defence forces for armour plating and to build the Collins class submarine."

HOW ANCHORS WORK

When an anchor is deployed and has load applied, such that the anchor orientates in the direction of load, then the fluke angle to the seabed is about 32 degrees. This angle is common to virtually all anchors.

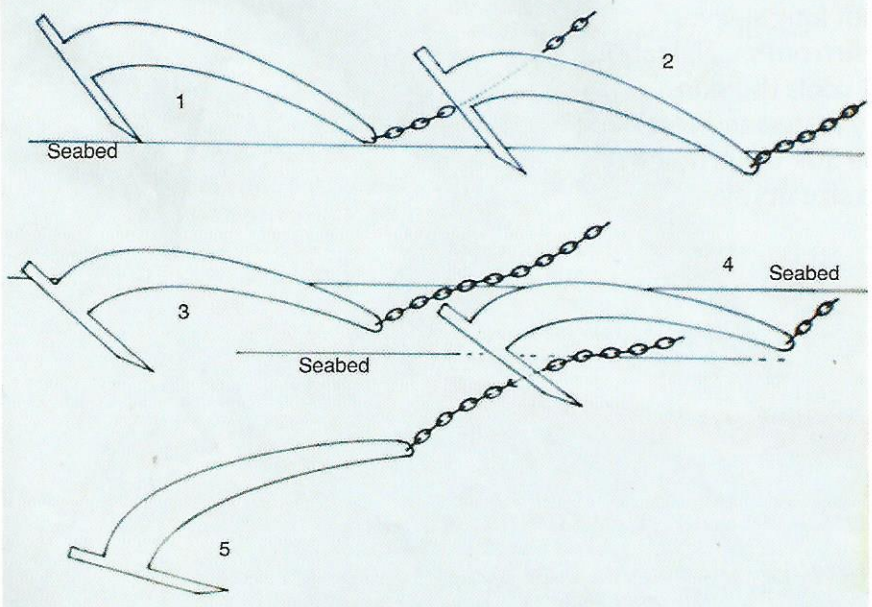
As the anchor 'sets' two things happen: the toe of the fluke engages and digs into the seabed and almost simultaneously the shackle end of the shank also begins to bury (see 1 on diagram). As the anchor digs more deeply the toe buries as does the anchor shackle pulling with it more and more chain (see 2, 3 and 4).

The anchor would reach maximum depth when the resistance imposed by the chain to further burying balances the ability of the fluke to bury it further. As that resistance of the chain imposes on the fluke, the fluke attack angle reduces from that original attack angle to something much less, until the fluke is simply slicing through the seabed like a turf cutter (5). This phenomena is well known and the US Navy have the ability to calculate shank angle knowing seabed density and anchor characteristics.

Because this characteristic is well known anchor makers have gone out of their way to reduce resistance to diving which is why we have shanks made from thin high tensile steel, the thin shank reduces resistance to burying. But roll bars, swivels and of course the chain add to the resistance - which is why having a smaller surface area chain is advantageous.

If you look at a well set anchor, this is something that can really only easily be achieved in clear water, usually over a sand seabed. It is common not to see the anchor at all, or only the top of the shank. Quite often the anchor has dived out of sight dragging even a few metres of chain with it.

Obviously the deeper set your anchor, the more chain buried the greater the holding capacity.



The Fortress is good because it has no ballast and is about 30% bigger in surface area than the Excel or Spade.

The focus on lightweight alloy anchors is simple: you can deploy and retrieve safely and easily by hand and in our experience over a number of years the alloy anchors perform the same as their steel twins.

Why then do we continue to use the steel Excel? We had it before defining our 'anchor phoilosophy' and no-one is going to swap it for an alloy version! Simple economics plus we do not believe in reliance on one primary anchor, all our anchors, if push comes to shove, can be primary, or bower, anchors.

We have identified that most anchors drag as a result of veering, the sailing of the yacht about the anchor caused by wind sheer or unstable wind gusts. A bridle and twin anchors set in a 'V' reduces veering.

Reliance on one anchor does absolutely nothing to reduce veering and unless the anchor is three times the weight (in crude mathematics: three times the weight slightly more than doubles surface area and providing a hold increase of about 75%) it has less holding capacity than two single anchors. So, if we deploy two anchors in a V we will reduce veering and our two anchors have a holding capacity at least equal to a steel 45kg (or alloy 24kg) model of the same design.

The downside is we must be able to deploy two anchors and alloy are easier to handle than steel.

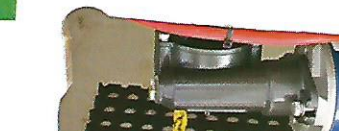
Our philosophy is therefore very different to Dashew and most others who invariably use one anchor bigger than that recommended. There is nothing wrong with a slightly bigger anchor, arguably if it makes you feel better it is worth the extra money!

We conducted a forum survey: we simply asked for evidence of dragging of modern anchors and the size of anchors used. Modern anchors do drag but only under exceptional circumstances, catching an abandoned crab pot, a discarded gas cylinder (as in our case) and occasionally when the fluke clogs with weed.

Most people when they buy a modern anchor, illogically, upsize. But even those who believe the hype, like us, who buy a smaller anchor, do not report of dragging. Modern anchors if set sensibly in a sensible location appear reliable. But do not get complacent, anchor alarms on your chart plotter or phone are still invaluable.

Previous usage

Our rode is 50m x 8mm PWB Grade L and a second rode of 20m of 8mm chain attached to 40m of 12mm 3ply nylon. If we needed to we have enough cordage to cobble together a third, all cordage rode.



TOP: An almost fully set Excel.

ABOVE: 75m of 6mm chain in *Josepheline's* anchor locker, painted at 10m intervals and at 1m intervals for the first 5m.

Our windlass is a vertical Muir Atlantic 1250. The rode is about 12 years old and rusting as it has lost all of its galvanising. At the crowns, where the links rub each other, we have lost steel getting toward the critical 10% where strength looks to be compromised.

The catamaran originally had a 30m rode, which was far too short and we replaced it with a 50m length. The windlass is original, well used and 15 years old.

We would like to extend the rode to about 75m as in some anchorages 50m is a bit parsimonious. But the current chain builds into towers in the anchor locker about every 20m retrieved, so the tower needs to be knocked down and then moved to allow the retrieval of the next 20m. Our locker, or the space under our windlass, is shallow. Pushing 20m of chain around in an anchor locker is not easy, there has to be a way of making it easier and safer.

The philosophy

We are impressed with the idea of weight saving.

We liked the idea of saving space or, at least, the chain taking up less space. The disadvantage of heavy chain and a swivel in allowing the anchor to set deeply was well illustrated with our own tests.

We do not believe in catenary, are firm adherents to the idea. If you want to reduce snatch loading, use a proper snubber (see breakout box on page 30) and be prepared to use two anchors set in a V to reduce veering.

Chain and connectors

We found that G80 chain made to EN818-2, a common European standard and freely available in Australia from either Europe or China, fits a standard 6mm Muir or Maxwell gypsy.

We sent a length to Muir to check, we assume that the same chain will fit other gypsies but it is easy to check. If a windlass maker knows you might be buying a new gypsy or windlass, send them 0.5m of your chosen chain and they will check for you.

Most windlass makers have spreadsheets defining which gypsies accommodate which chains and which of their windlass.

We took short lengths of Scandinavian Gunnebo Scandinavia 6mm x G80 and had these lengths Armorgalv coated under different process conditions at Newcastle in Australia (see break out box). Armorgalv is a standard process, used by the US military for chain tie-downs for vehicles on landing craft; a standard specification for HT bolts for wind farms; in the mining industry for roof supports and in North Sea oil for a variety of chain applications.

We knew the normal shackles would not fit the 6mm chain, the clevis pins are too big. So we sourced 6mm x G80 Excel Omega links from Van Beest of Holland, they match the G80 chain for strength. We subsequently upgraded our links using G100 clevis pins instead of the G80 pins but kept the G80 bodies.

We had trial lots of the Omega links also Armorgalv coated. We tested the trial chain lengths and Omega links to failure break, at Robertsons, Newcastle. In parallel we were further developing the Boomerang, the bent link for self righting our anchor (CH April 2015) and other components, primarily chain hooks, and had them Armorgalv coated at the same time.

SNUBBERS

From looking at yachts at anchor most owners have no idea of the use of a snubber. A very few know they offer the ability to completely absorb damaging snatch loads, a few more think they are simply to take the load off the windlass and stop the chain rattling on the bow roller and disturbing sleep in the forepeak.

Most do not bother with snubbers.

Owners think that chain catenary offers all the damping or snubbing effect needed when at anchor. This is perfectly true with a reasonable scope and up to about 25 knots of wind. Beyond 25 knots and certainly beyond 30 knots, that snubbing effect of the chain has effectively disappeared.

In a deep anchorage it is quite possible some yachts will not have enough chain, there is a finite amount that can be carried. Nylon has an approximately linear elasticity until it actually fails and will stretch, again approximately, 40% to failure. Consequently, if you choose the correct sized snubber it will offer elasticity, snubbing effect, all the time. When you need it your chain is a simply an inextensible steel cable but a nylon snubber will keep working.

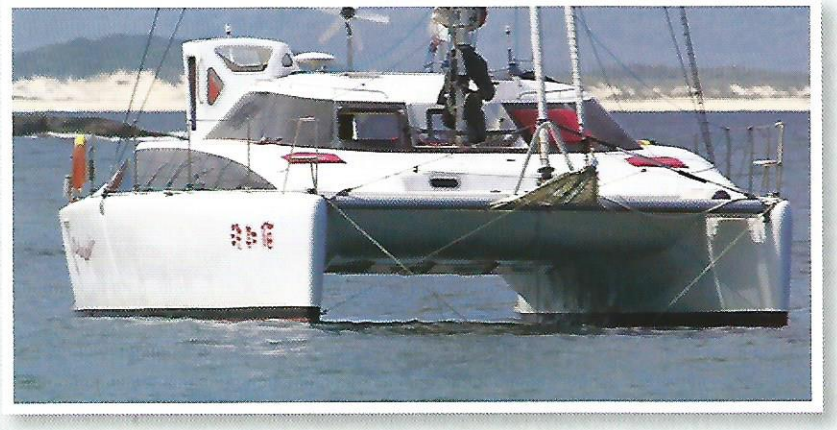
The reality is that if you use a snubber then the chain and nylon work together, two snubbing mechanisms the catenary of the chain and the elasticity of the nylon will dampen any snatch loads.

Reduce the snatch loads and you remove those same destructive snatch loads on your anchor. A smooth and snatch free night for you at anchor is a smooth and snatch free night for your anchor as well, as it has less reason to drag.

Because smaller chain sacrifices some of the positive effects of catenary, in favour of less weight etc, the use of snubbers is much more critical. Don't leave home without your snubber.

To be effective snubbers need to be long, think in terms of 10m. If the snubber is too thick, it will not stretch and if too thin it will wear out quickly. For a 40'/45' yacht a 11mm/12mm x 10m snubber works well and if you use this sort of snubber you will see it visibly stretch, doing what is intended.

To accommodate a 10m snubber we attach to the transom horn cleats, run up the side decks, pass through turning blocks on the bow and then to a common chain hook. Being a catamaran, we have two snubbers. In effect a bridle and this would be sensible for a larger monohull. Smaller yachts, say 35', could simply use just one snubber run up the side decks but the individual needs to work out how to get the snubber 'outboard'. Fairleads or the bow roller are the obvious way, using suitable covers for abrasion.



ABOVE: The snubbers on *Josepheline* are attached to the transom, run through the stanchion bases to a turning block on the bow and then to a common chain hook. This length of snubber gives more than adequate elasticity to absorb the energy of snatch loads.

The test results were satisfactory and the Omega links with the G100 clevis pins were well over strength, much stronger than the chain.

High tensile chain has a reputation for being subject to hydrogen embrittlement and of being brittle. Neither have any foundation in this case, nor in fact (see breakout box on page 25).

From our previous testing of Armorgalv coating we had identified that coating thickness was critical. We had concluded that to match the best conventional hot dipped galvanised coating we needed a coating thickness of 100 micron and specified this to Armorgalv. A 100 micron coating thickness is much higher than they would normally coat and higher than that specified, 70 to 80 micron, by the US military.

The reason for the much thicker coating is very simple: seabeds are very abrasive. Most galvanised coatings simply protect from corrosion, we needed corrosion and abrasion resistance. The 100 micron coating thickness demanded was accepted but we would not have progressed without adequate thickness as rapid coating loss means short life and we did not want to be replacing chain too frequently.

> "...in no time at all that investment is 'yesterday's hero'."

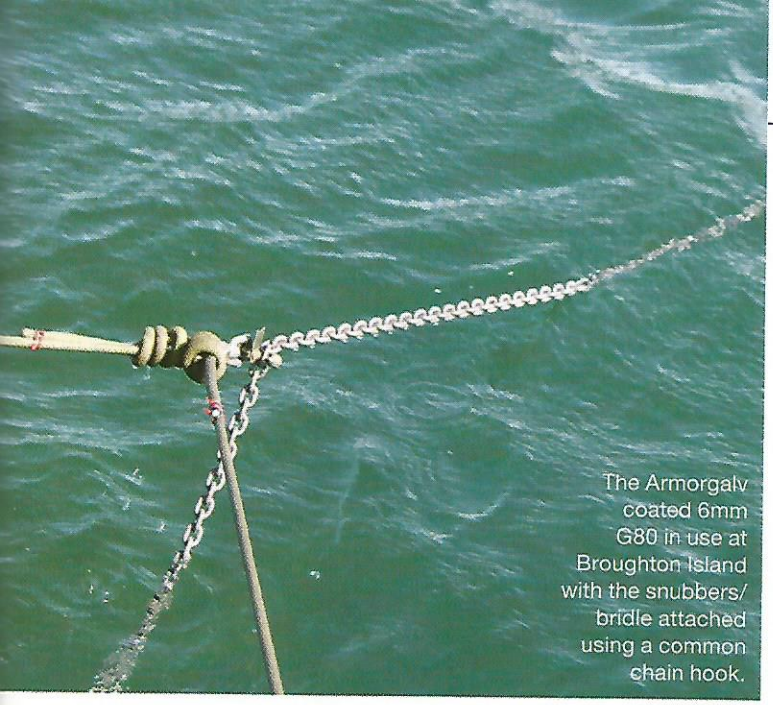
To monitor thickness in production we ground some links of chain flat, so ground links in half, lengthwise. We attached these ground links through the length of the chain. We could then measure the thickness with a magnetic coating thickness meter on the 'flat' of the ground links.

We also measured coating thickness gravimetrically, we weighed, dissolved off the coating with acid, reweighed and, knowing the surface area as chains are a toroid and two cylinders, could calculate thickness.

Control of coating thickness with Armorgalv is relatively easy, the zinc added to the process is all used in coating the objects being coated so if you know surface area and required coating thickness then its a simply piece of arithmetic to calculate how much zinc to add.

We bought 75m of 6mm x G80 from Gunnebo and also 15m of Chinese-brand 6mm x G80 from Ian Allen Marketing. We had the full 90m (75m + 15m) and Omega links, Armorgalv coated to our 100 micron specification.

The Chinese chain is branded Titan, but not to be confused with CMP's Titan chain also made in China! We tested lengths off both ends of the 75m and 15m coated lengths for strength. We tested both magnetically and gravimetrically for coating thickness. Strength was almost 8mm G40 quality, the Armorgalv process degraded strength slightly from the specification G80 but



The Armorgalv coated 6mm G80 in use at Broughton Island with the snubbers/ bridle attached using a common chain hook.

much stronger than typical G30 quality. Elongation to break (lack of brittleness) was as good as good G30 and better than standard American anchor chain, G30, G43 and G70, by 30% to 40%. Coating thickness was a consistent 100 microns. The Omega links remained well over strength.

The intention was to have the Omega links as enlarged end links on the chain. We could then use standard 3/8th" Peerless Grade B rated shackles, with the bow through the anchor shank and pin through the Omega link.

The G100 clevis pin of the G80 Omega links was attached to the 6mm x G80 chain. For the 15m of Chinese 6mm G80 chain we have attached in a similar way to our 40m of 12mm 3ply nylon as our second rode.

Because we are using a Boomerang we have used 5/16th" Armorgalv coated G80 (from America) because we did not have enough Omega links to complete the whole assembly with 6mm chain. We are having further Omega links coated so that the whole rode is 6mm x G80.

Carrying the lightweight theme to its logical conclusion we have temporarily retired our 15kg steel Anchor Right Excel and are using our 8kg alloy Excel as the primary anchor. We continue to carry the alloy Spade A80 and the Fortress FX 23.

The gypsy

We had discussed with Muirs a purchase of a replacement gypsy, the existing gypsy was 8mm and we obviously needed a 6mm gypsy.

We found the replacement gypsy cost high and, having investigated, we decided we would invest in a new windlass from Maxwell. By deciding on the RC 8-6, a 6mm windlass with a 1,000 watt motor rather than upgrade the 15 year old Muir, the cost of the Maxwell simply made this a sensible decision.

In replacing the Muir we identified it had been installed incorrectly with the electric motor directly under the chain and the motor casing severely corroded. This made our decision to renew a correct move as the life expectancy would not have been great had we kept the Muir.

Spending a lot of money on a new gypsy with a short life expectancy motor looked like false economy. Maxwell bent over backwards to provide fullest technical information, prior to our purchase, on the performance of the windlass and on installation.

It is possible to buy second hand gypsies, many windlass are retired for a whole variety of reasons: commonly gearbox or motor failure, less common are bent shafts. Six millimetre gypsies are like hen's teeth. But 8mm, 10mm and 12 or 13mm much more common.

There are an amazing number of different windlass designs and finding one to match yours might need some patience. If you are looking for a second hand windlass, boatyards are a good place to start.

Usage

We have now painted marks every 10m on the 75m length and have painted every other metre length for the first five metres. We know visually how much chain we deploy and how much chain is buried when the anchor is set (see break out box).

The windlass has been installed, chain loaded and used. We tested the chain initially with the steel Excel on Pittwater and then with the alloy Excel in Shoal Bay and Broughton Island. We also tested the 6mm chain with both the Fortress and Spade anchors.

Basically usage of the chain has been something of a non-event. There have been no problems. The big change we notice is that 75m takes up much less space than 50m of 8mm chain and we can retrieve 30m of chain without towering in the chain locker being an issue.

ABOVE: A fully set Excel, with 2m of chain completely buried.

RIGHT: The link size of 6mm chain is too small for a comparably strong relaible shackle (a 3/8th" Grade B shackle with a 7/16th" cleric pin) so a larger link need be used. Van Beests Omega links were found to be satisfactory. It is not a unique solution and Maggi use Rud Omega links, but they are in our view, over large. From left to right, 6mm chain and 6mm Omega link, 8mm chain and 8mm Omega link, 8mm chain and Maggi/Rud 8mm Omega link and 10mm chain and a 10mm Maggi/Rud Omega link. Maggi obviously are not concerned the large links might unbalance the anchor and restrict its ability to dive. The shackle is a 3/8th" shackle.

The windlass retrieval speed is two times that of the original Muir windlass. We have not had opportunity to test the 6mm x G80 and nylon mixed rode.

At the time of writing we have some accelerated abrasion tests in progress of the Armorgalv coating of the 6mm x G80 in comparison with other chain samples. We will also be critically looking at other aspects of the chain and windlass performance, about which we will report in the fullness of time. We will also be extending the investigation by Armorgalv coating a G100 chain to identify if there is any potential to produce something even stronger.

Costs

Gunnebo 6mm x G80 costs between $6 to $9 per metre, it depends who you buy from. There are other sources of G80 in Europe and America.

Chinese 6mm x G80 costs $3/m from Ian Allen Marketing. Chinese G80 is available from a number of suppliers and might be available more cheaply either by more aggressive negotiation or buying more than 15m. Buying direct from China is slightly complex and potentially expensive as you need to be cognisant of import documentation and are subject to the vagaries of Australian ports and their costs.

If we were to repeat the exercise, knowing what we know now, we would buy 90m of Chinese 6mm x G80 but would check the specification of the Chinese chain prior to coating.

We did have a test certificate, but were then a bit cautious. If no test certificate were forthcoming, from a reputable testing agency, showing it met G80 minimum specification we would not buy it. This should apply when buying any chain.

6mm Omega links costs vary, around $6 each. These are available from a number of sources, including China, but we do not know quality of the latter; we are investigating.

Armorgalv coating $5/kg for 6mm chain, this might be negotiable for larger batches. For comparison, normal hot dipped galvanising (HDG), costs about $4/kg.

Cost of processed Gunnebo chain, worst case $14.0/m. Cost of processed Chinese chain, $8.0/m. For comparison:

- PWB 8mm Grade L ex-Whitworths: $15.0/m
- CMP 8mm Grade L ex-Whitworths: $11.3/m
- ACCO, Peerless, 1/4" x G70, ex-West Marine, USA: AU$25/m

Will these changes shake the industry to the seabed? If traditional chain makers are unable to innovate and offer real extra value they will inevitably be unable to compete with much cheaper offshore manufacture. Most anchor chain in Europe is now imported, from China.

The big American chain makers sell two product lines, imported from China and their own production. CMP is already importing from their own factory in China and it is inevitable that someone will identify the opportunity in Australia and buy good quality Chinese chain and simply merchant it.

The fact that China is now producing top of the range G120 chain is indication that the issue is right across the spectrum of product. But there are opportunities and maybe this article indicates one way chain makers here might stay in the business of manufacture.

As a minor example Dashew has been building his motor yachts in New Zealand for a number of years, equipped with G70 chain from America. It is not rocket science, but remember it was reported in *Cruising Helmsman* first!

We want to support Australian production but we expect the extra costs that have to be paid be reflected in better quality or technical innovation.

cruisinghelmsman Jon Neeves

Jon and his wife Jo have owned their Lightwave 35, Josepheline, for almost 10 years. They manage to get away most years for a long cruise of 3-5 months and more recently their chosen destination has been Tasmania's west coat. Having honed skill on the race circuit and bluewater classics, the more leisurely lifestyle of cruising has allowed Jon to become a regular contributor.