

Roofing matters...

Fasteners matter - greatly

Don't underestimate the critical role of roofing fasteners when it comes to the overall performance of a roofing system. In this instalment of our series that brings you practical insight from the experts, we learn more from Reitze Hylkema, Managing Director of Kare Industrial Suppliers, on how to select a suitable fastening system that won't fail.

Too often, proper attention is given to fastener selection only *after* fasteners have failed and problems start to occur. This is unfortunate because, by following a few straightforward guidelines upfront when choosing fasteners and corrosion-resistant coatings, you can make the correct selection to ensure that the fasteners don't become the weak link in the roofing system.

Since the publication in November 2009 of the revised standard relating to roofing fasteners, namely SANS 1273, the roofing and cladding market has been offered a wider range of corrosion-resistant coatings on roofing fasteners. However, the roofing professional should be aware: Despite some rather exaggerated performance claims by the importers, a lot of available fasteners do not conform to the SANS 1273 coating requirements.

FASTENER SELECTION

While more outdated types of fasteners are still being used in the roofing market and are still listed in SANS 1273, self-drilling type fasteners are increasing in popularity and are the focus of this article.

Factors to consider when assessing roofing fasteners include:

1. Fastener point selection
2. Fastener head selection
3. Fastener length calculation
4. Corrosion considerations
5. Material compatibility

FASTENER POINT SELECTION

The drill point diameter is in correlation with the thread diameter and influences the pull-out values obtained in different steel thicknesses.

To select the correct drill point, you need to know if the screw will be drilling into timber, steel, or another material.

1. If fixed into *timber*, use a screw with a Type 17 point:



2. If fixed into *steel*, use a screw with a drill point that has the correct drilling capacity.

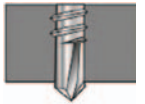
No.1 point: Stitching of thin gauge material (i.e. flashing and sheeting; end laps and side laps) and fixing into thin gauge metal battens.



No.2 point: 2.5mm drilling capacity in cold rolled steel.



No.3 point: 4.5mm drilling capacity. This is by far the most popular drill point and commonly used for fixing sheeting to 2.5mm cold rolled lip channel.



No.5 point: 12.5mm drilling capacity. This drill point is used on hot rolled steel sections.



3. When fixing *fibreglass, polycarbonate and fibre cement sheeting*, an oversized hole in the sheeting is required to allow for expansion and contraction of the sheeting. By using a winged self-drilling screw, the reaming process can be done while fixing the fastener.

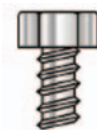


FASTENER HEAD SELECTION

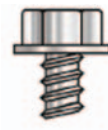
When IBR and corrugated profiles are fixed, the fasteners are fixed through the sheeting into the purlins. This is referred to as a pierced-fix roofing system. Either hexagon head, hex washer head or hex flange head screws are used for pierced-fix applications.

Hexagon head and hex washer head screws: Used in combination with bonded washers.

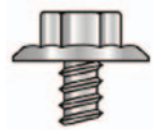
Hex flange head screws: Normally assembled with a rubber seal not requiring an additional bonded washer.



Hexagon head



Hex washer head



Hex flange head



With concealed-fix roofing systems a clip, bracket or halter is fastened onto the purlin, and the sheeting is clipped, hooked or seamed onto the clip. These systems allow the sheeting to expand and contract without movement restriction caused by pierced fasteners. As a result, much longer continuous spans can be rolled. Most of the concealed-fix roofing system requires a wafer head fastener that fits flush in the recess of the clip.



Wafer head

FASTENER LENGTH CALCULATION

1. Pierced fixing: You must add the following numbers in order to calculate the correct fastener length for pierced fixing through the crest of the sheeting:

- The profile height of the sheeting.
- The thickness of washers and seals.
- The compressed thickness of insulation material between the sheeting and the purlin.
- The thickness of the purlin in the case of steel purlins.
- The length of the drill point and the first three threads above the drill point in the case of steel purlins.
- 35mm penetration into the timber in the case of timber purlins.

The length obtained is the recommended length of the fastener. If this is not a standard length, then the next longer standard length is recommended.

When fixing through the valley (pan) of the sheeting, the same calculation applies, but the profile height is omitted.



2. Concealed fixing: When fixing concealed-fix roofing systems, the correct fastener length is calculated as follows:

- The compressed thickness of insulation material between the sheeting and the purlin plus the height of any packers between the insulation and the purlin.
- When fixing into steel purlins, add the thickness of the purlin, the length of the drill point and the first three threads above the drill point.
- When fixing into timber purlins, add 35mm for penetration into the timber.



CORROSION CONSIDERATIONS

The corrosion resistance requirements of roofing fasteners as described in SANS 1273–2009 draws on the information published in the Australian Standard AS3566.2-2002. In the standard, corrosion-resistant coating types, thicknesses and compositions are specified and linked to environmental categories.

The environmental categories are based on ISO9223, which lists the following corrosion resistance classes:

CORROSION RESISTANCE CLASS	ATMOSPHERE OF INTENDED USE
1	General use in internal application
2	Internal applications with significant condensation levels; External applications: Inland rural & mild urban
3	External use in moderate industrial or marine environments
4	External use in severe industrial or marine environments
5	External use in very severe industrial or marine environments

Only Class 2 and higher classes apply to external roofing. The specification of the coating for self-drilling screws in these categories is as follows:

CORROSION RESISTANCE CLASS	MINIMUM POROSITY RATING	COATING TYPE	COATING COMPOSITION (BY MASS)	MINIMUM LOCAL METALLIC COATING THICKNESS (µm)
2	-	Electroplated Zinc	98% Zinc	12
3	-	Electroplated Zinc	98% Zinc	30
3	8	Mechanically plated Zinc	98% Zinc	40
3	8	Mechanically plated Zinc/Tin	20-23% Tin, Balance Zinc	25
4	8	Mechanically plated Zinc/Tin	20-23% Tin, Balance Zinc	45

Note: SANS 1273–2009 lists sherardizing and hot dip galvanizing as suitable corrosion-resistant coatings for fasteners *other* than self-drilling and self-tapping screws.

COMPLIANCE TESTING

In order to prove compliance with the corrosion-resistant coating requirements of the standard, at least one of three testing methods must be conducted:

1. Accelerated laboratory testing.
2. 'Deemed to comply' based on the porosity rating, the coating thickness and the coating composition.
3. Real-world testing.



ACCELERATED LABORATORY TESTING

Accelerated laboratory testing is conducted according to AS3566.2-2002 and requires salt fog tests and sulphur dioxide (Kesternich) tests to be performed on metallic-coated self-drilling screws.

Salt spray tests attempt to simulate a marine environment and to test the effect of salt-laden air on fasteners. Sulphur dioxide tests try to simulate an industrial environment and to test the effect of industrial fall-out on fasteners.

The fasteners being tested are first driven into a 1.5mm-thick galvanized steel plate and removed, or, in the case of screws for timber, the screws are driven a minimum of 30mm into untreated pine and then removed. Only *after* this procedure can the screws be tested.

The fasteners must pass the following tests without showing signs of red rust on more than 5% of the head and shank of the self-drilling screw.

	MINIMUM HOURS IN NEUTRAL SALT FOG TEST	MINIMUM HOURS IN SFW 2.05 SULPHUR DIOXIDE TEST
Class 2 fasteners	240 Hours	5 Cycles
Class 3 fasteners	1000 Hours	15 Cycles

It is important to note that accelerated laboratory testing is not listed in the standard as a method to test Class 4 coatings.

Also, it bears mentioning that, while laboratory tests can be quite useful to obtain comparative test results done between different fasteners, there are some inherent flaws in this type of testing. For example, these tests only test performance in one specific type of environment, being either marine or industrial, whereas fasteners in industrial areas are often also in close proximity to the coast (think of areas like Richard's Bay, Durban, Cape Town and other coastal cities). A combination of ultra-violet radiation, condensation and industrial pollution can also contribute to high corrosion rates (Gauteng and Mpumalanga regions), but such environments cannot be duplicated in laboratory tests, meaning the results are not a completely true reflection of how fasteners will perform in reality.

Moreover, laboratory tests are conducted at a temperature of 35°C but in the real world, temperatures on a roof might reach 80°C. As corrosion rates increase at higher temperatures, the actual corrosion rate will therefore often be much higher than the results obtained in laboratory tests.

Thirdly, when fasteners are tested in a laboratory they are tested in isolation – they are not in contact with a roofing washer, roof sheeting or clip, insulation or the purlin. All these dissimilar materials that make up the complete roof structure lead to galvanic cell corrosion in the real world and will affect the service life of roofing fasteners. Again, laboratory tests cannot provide completely reliable results on which to determine the expected life span of a fastener.

Another drawback of laboratory tests pertains to the interpretation of test results. If a fastener passes a 1,000 hour salt spray test, what does it really mean? How long will that fastener last if it is used on a shopping mall roof in a coastal town? If a fastener passes 15 cycles in a Kesternich test, how long will it last when used on the roof of a chemical factory? The laboratory tests cannot provide these answers, and therefore are in essence best limited to comparative testing.



Above: Laboratory test cabinet



Above: Fasteners sold in South Africa as Class 4 tested by SABS failed dismally in salt spray test.

DEEMED TO COMPLY

Fasteners are 'deemed to comply' with the standard based on three criteria: Whether or not the coating thickness, the coating composition and the coating porosity conforms to the specifications of the table in the standard. This method of testing can be used for Class 2, Class 3 and Class 4 fasteners.

The rationale behind this method is that if a coating contains a specified percentage of zinc or zinc and tin, and the coating has a specified thickness and a porosity rating of at least 8 on the scale given in the standard, then the screws will be suitable for use in specific environments.



Above: Coating thickness.

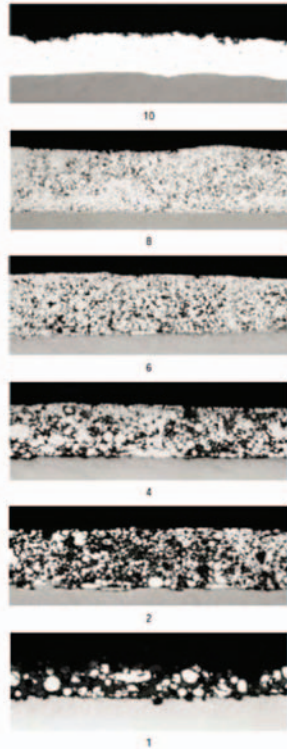


In order to achieve compliance this way, the following tests are required:

- The coating thickness must be measured on the flange of the head of the fastener or on the side of the hexagon head. On wafer head screws, the thickness must be measured on top of the head. Three separate readings must be obtained and all three must meet the standard requirement.
- The coating composition of zinc/tin coatings must be analysed. The tin content must make up between 20% and 23% of the coating, with the balance in zinc.
- The porosity of mechanically plated screws must be inspected by placing a cross-section of the coating under a microscope with a magnification of 500X and comparing the image with the images listed in the standard as shown below. A rating of 8 is required to comply with the standard.

Where the 'deemed to comply' method falls short is in the fact that there is no government institution or independent authority that monitors the true quality of coatings that is sold to the South African market. Very few fastener manufacturers/importers in South Africa provide reputable and independent test results that confirm compliance to the 'deemed to comply' table of the standard. In fact, many fastener distributors have no test results at all, while others present dubious and misleading reports.

The three applicable tests all have to be done in a laboratory with relatively expensive equipment, which makes the continuous testing of fasteners an expensive exercise. But irregular testing defeats the purpose of testing, as porosity and tin content in fasteners tends to be very inconsistent. Clearly a more effective option is to test fasteners where they will be used, meaning outdoors in the real world, exposed to harsh conditions, under varying temperatures, and in contact with other roofing materials.

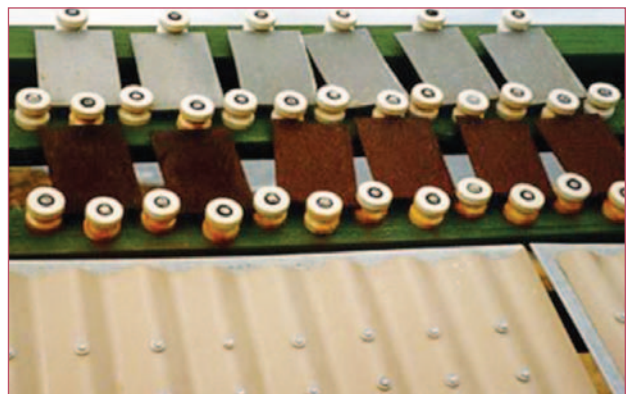


The zinc loss of the coupons is monitored at regular intervals.

- Testing Class 3 screws: Once the coupons have lost 21 microns of zinc, 95 out of 100 screws that are tested must show no signs of red rust on the head and/or shank of the fastener. Put another way, if red rust shows on more than 5% of the fasteners as described, the fastener has failed.
- Testing Class 4 screws: For this class, the above rule applies once the coupons have lost 42 microns of zinc.



Above: Covered (unwashed) real-world test panel in marine environment.



Above: The top row shows the zinc coupons used as the corrosion rate indicator.

REAL-WORLD TESTING

Real-world testing is the most reliable and realistic method of testing as it combines the fasteners, the washers, the roof sheeting and the trusses in contact in an aggressive environment that can combine varying temperatures and conditions.

On a real-world test site, zinc coupons are fixed on the same exposure rack as the fasteners and sheeting. The test racks comprise exposed and sheltered panels to simulate the effect of rain washing the fasteners and roof sheeting – an aspect that has a big influence on corrosion (sheltered being worse).

(NOTE: The real-world test site shown here is located at King Island, Australia. This test site is run by ITW Buildex, and corrosion results are independently monitored by the Australian CSIRO.)



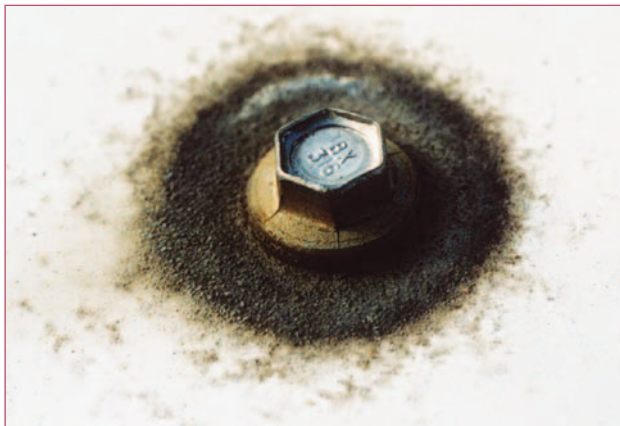
MATERIAL COMPATIBILITY

When selecting fasteners, it is important to ensure that both the fastener and the corrosion-resistant coating are compatible with the roof sheeting. If not, the result will be galvanic corrosion. It is therefore advisable to carefully read the specifications of the sheeting manufacturers. Often the warranty on sheeting material is subject to the correct fasteners being used.

As a general guideline, the following combinations of fasteners and roof sheeting are recommended:

	Class 2 Zinc elec- troplated	Class 3 Mechanically plated	Class 4 Mechanically plated	Class 5 Stainless steel
ZINC COATED STEEL	X	X	X	
ZINC ALUMINIUM COATED STEEL		X	X	
PAINTED ZINC COATED STEEL		X	X	
PAINTED ZINC ALUMINIUM COATED STEEL		X	X	
ALUMINIUM & PAINTED ALUMINIUM			X	X
STAINLESS STEEL & PAINTED STAINLESS STEEL				X

If using dissimilar metals together is unavoidable, it is advisable to use a non-conductive sleeve around the fastener to prevent contact between the fastener and the sheeting. This is essential, especially in highly corrosive environments. Usually this will necessitate the pre-drilling of an oversized hole in the sheeting to accommodate the sleeve.



Above: A 316 stainless steel fastener in contact with a painted zinc/aluminium-coated steel roof sheet, resulting in corrosion.

VALLEY FIXING, LONG SPANS, FILINGS AND MORE

There are some additional factors to consider when selecting fasteners:

Valley fixing does not allow for expansion and contraction of the roof sheeting and will result in the hole around the fastener becoming elongated, leading to possible leaks. In addition, rain runs off the crest of the sheeting and into the valley, and fastener heads will form an obstruction in the valley behind which debris will accumulate. This will lead to premature corrosion of the sheeting behind the fasteners. Therefore, in pierced-fix roofing applications, it is advisable to fix the screws through the crest of the profile and not through the valley (pan) of the sheeting.

Is not advisable to use pierced-fix roofing systems on spans longer than 18m, as expansion and contraction will cause fasteners to work loose over time and strip the holes in the purlins. This span length is reduced when fixing into thin gauge metal battens. For longer spans, concealed-fix roofing systems are recommended.

All swarf and metal filings should be removed from the roof sheeting after the roofing fasteners have been installed, as these filings will cause corrosion and damage the roof sheeting very quickly.

If bonded washers are used, it is important that the corrosion resistance of the washers matches that of the fasteners and the roof sheeting. Non-conductive rubber should be used on washers to eliminate the problem of pit corrosion, especially on zinc/aluminium-coated sheeting and aluminium sheeting.

BE SURE, NOT SORRY

Selecting the correct fastener type and appropriate coating before the start of the project will prevent costly repairs and eliminate problems caused by premature corrosion in the long run. If there is any doubt about which fasteners and/or coatings to use, consult with the roll former or a reputable, specialist fastener supplier.

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