500mm below the ground line can be expected to be very low. Given a conservative estimate of 10-15 years for the galvanized coating in the over 500mm buried steel sections, the corrosion rate of the deeply buried steel [once the coating is removed] could be conservatively estimated at 10-15 micron per year in normal soil conditions.

This means that the deeply buried section of the steel sleeve should have a service life in the order of 75 years, if the loss of 1mm of steel in this section of the pole is deemed to be acceptable within the structural design parameters for the section."

Given that the design bending moment on the buried section of the steel sleeve reduces quite quickly below ground, a loss of 1mm of steel section is well within the structural design considerations of the pole.

We believe that the timber could be the governing factor in the life of the pole, depending on the ground conditions. And given timbers in ground service life, this should be much greater than 50 years since it is now above ground.

16. How should the KPOLE TSB be put into the ground and installed into the line?

The installation of the KPOLE TSB should be as per normal timber pole installation procedures. The poles will be approximately the same weight if not lighter than equivalent timber poles. Since the timber section is at the top of the pole, normal timber pole procedures may be used for the attachment of services at the top of the pole.

The minimum embedment used in design was based on 10% x Total pole length +800mm, as requested by a number of utilities. The design loads given also assume that the top 200mm of soil is ineffective and was ignored in the design.

This in no way implies that the embedment used in determining the nominal capacities is adequate for each situation, and it is the responsibility of the line designer to specify the required embedment based on the particular loads and soil conditions present. The embedment depth quoted above is the minimum for the KPOLE TSB. The embedment depth can be increased or decreased, but the effect on footing strength and tip load capacity should be considered for each case.

The use of cement stabilised backfill is recommended, but it is the responsibility of the line designer to ensure the foundation design is adequate.

17. Isn't the harvesting of native forest bad for the environment?

No. Timber is the only truly sustainable, renewable building material when harvested using managed forest techniques. The more we use, the more we can grow, and hence the more carbon dioxide we extract from the atmosphere and store in the wood as carbon. Old growth forests are carbon neutral, whereas regrowth forests are carbon sinks. The KPOLE TSB pole is an environmentally sensible option when compared to other alternatives such as concrete and full length steel. While accounting for the steel component, the KPOLE TSB still provides a negative carbon emission status in production as the timber component makes up approximately 75% its length. No other material can claim the environmental credentials of timber with up to 250kg/m3 of CO2 absorbed from the atmosphere (possibly more according to more recent data) during the tree's growth cycle, while the production of steel and concrete expel 5,300kg/m3 and 120kg/m3 respectively [1]. Sustainable management of the resource base from which KPOLE TSB poles are drawn also greatly contributes to the positive environmental impact of this new product, and this has been highlighted by our major supplier Forests NSW achieving certification to the Australian Forestry Standard for sustainable forest management.

[1] Data obtained from www.ecoselect.com.au

Koppers KPOLE range

For further information on Koppers KPOLE range of utility distribution and transmission poles, telecommunication poles, foundation and marine piles please contact:

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www.koppers.com

Sustainability through Innovation

Koppers new utility pole, the KPOLE TSB combines renewable hardwood resource with engineering innovation to create a competitive and sustainable solution to the supply of key size hardwood poles in meeting industry demand. With the proven benefits of timber, the KPOLE TSB is engineer designed and certified to ensure long lasting performance, compatibility and compliance to the safety requirements of network asset managers.

Sustainability through innovation is delivered with Koppers KPOLE TSB.

KPOLE TSB poles combine a steel sleeve with precision machined and treated 'select' grade hardwood to ensure a durable and tight long lasting fit. Engineer designed and certified to AS4676, AS4100 and AS1720.1 the KPOLE TSB has been prototype tested to destruction for end user reassurance and design confirmation. Representing an environmentally sensible option when compared to alternatives, KPOLE – TSB provides network asset owners with a sustainable long term timber utility pole solution. Intended to compliment the ongoing sustainable supply of key size treated hardwood timber poles the KPOLE TSB also ensures continuity of existing work practices – for installation and overhead line assemblies, compatibility with the existing pole asset profile, and all the product benefits associated with timber poles.

1. Has the KPOLE TSB been tested?

Yes. The structural proof testing was conducted in accordance with AS4676 on KPOLE TSB prototypes in a horizontal cantilever test rig at Koppers Grafton plant. These tests confirmed the capacities given by the specialist design program that was developed for the poles.

2. How did the pole fail during testing? Is this expected in the field?

The steel section failed in buckling (progressive collapse) at the ground line during testing. In the field the steel section is expected to buckle at either the groundline or the ventilation hole just below the butt of the timber – both of which are taken into consideration in the published design capacities. The failure mechanism may differ slightly from testing due to the difference between ground line supports in the tests vs. the field, but the test supports are conservative.

If the pole has been in service for a long period of time, constant loading on the timber causes the timber to have reduced strength due to load memory. This may mean that the timber governs the design for permanent loads (transformers, lines, etc.) If this is the governing load case then the timber can be expected to fail, however in most cases it is the short term load case that governs, in which the steel will fail first. Both of the long and short term capacities are given in the design capacities.

3. Is the KPOLE TSB susceptible to termite attack?

Unlikely, due to a number of design considerations. The KPOLE TSB is completely sealed below ground, thus preventing termite ingress. The steel section is immune from termite attack, and the timber component is deemed to be a termite resistant material, by virtue of its H4 preservative treatment according to AS1604.1. The timber component is located in an above ground situation making concealed termite entry into the KPOLE TSB unlikely.

KPOLE TSB poles were tested in the cantilever test rig at Koppers Grafton plant facilities to confirm design.

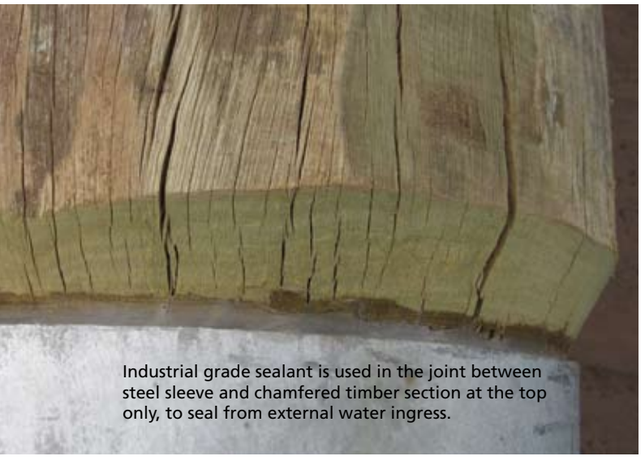
4. Is the KPOLE TSB equivalent to timber poles?

Yes, and more. The equivalent timber pole varies from state to state, and the KPOLE TSB generally lies in-between plain timber pole sizes so the more conservative equivalent is normally used to determine the nominal size. The KPOLE also has the benefit of being stiffer than the equivalent timber pole, and it retains more of it's design tip load when combined bending and compression is considered in accordance with AS4676:2000 "Structural design requirements for utility services poles".

However, at this stage the connection between the timber and the steel can only be rated to approximately 55kN (factored for ultimate limit states), or unfactored self weight + 4500kg. Under the high compression loads, the long term tip load capacity is reduced by approximately 50% due to bending and compression combined actions, while the short term tip load is barely affected.

5. Does the KPOLE TSB have a longer service life than timber poles?

It depends. When inspecting the steel section of the KPOLE TSB a lot of the subjectivity associated with timber pole inspections is reduced. For example, the Zinga Liquid Galvanizing and the underlying hot dip galvanizing (HDG) can each be measured to quantify the thickness of protection still in place at regular pole inspection intervals. The residual thickness can be used to reliably provide estimates on forecast service life of the structure, and it can be 'touched up' to reinstate the physical barrier to its original state.



Industrial grade sealant is used in the joint between steel sleeve and chamfered timber section at the top only, to seal from external water ingress.

6. How will KPOLE TSB perform when exposed to fire?

The KPOLE TSB is supplied with a 4.0m length HDG steel sleeve for the embedment section, with nominally 2.0m in ground and 2.0m above ground. The HDG protection provided to the steel section will perform well even when exposed to a fierce fire front, and the Zinga ground line protection if damaged is easily repaired by cleaning and re-coating. For low, fast moving grass fires the pole should not be structurally affected. However, in highly intense, longer lasting fire fronts where the temperatures can exceed 1000°C, the timber section of the pole will perform in the same way as full length timber poles which will depend on fire intensity, velocity and exposure to flying ash debris. However it should be noted that steel loses 50% of its strength when it gets to approximately 500°C, and this should be considered when sizing the pole by possibly considering a fire design load case.

Recent testing done by the CSIRO on steel structures exposed to bushfires suggests the temperature in the steel does not reach the 500°C, however, these tests were using a low intensity fire front, and there was no loads applied to the pole such as the wind loads commonly experienced during a bushfire, cable loads and transformer loads. Further testing is planned in this area, but there are theoretical solutions available if required. Koppers can work with you to provide the best solution.

7. Will the timber rot inside the steel sleeve?

Unlikely. There are a number of design features which have been included to manage moisture in the area of the timber and steel interface. The first measure was to minimise the ingress of rain water into the top of the steel section by beading off the intersection of the chamfered timber and the top edge of the steel section using an industrial silicon sealant/adhesive. The silicon seal should be checked as part of the routine pole inspection and supplemented if required over the life of the pole. The second measure is to ensure any moisture that does get in is free draining. The bottom of the timber is not sealed off, ensuring any moisture/rain water is free to drain and not accumulate. The third measure is to machine the strength group 2 / durability class 2 species timber portion before preservative pressure treatment. This ensures the timber is supplied with at least a coating of preservative prior to fitting into the steel section, and the timber selected has a high natural durability. Notwithstanding the above, the timber section is not in contact with the ground which significantly reduces the exposure risk to fungal decay from ground water and soil nutrients.

8. Can the timber condition inside the steel sleeve be inspected for rot and termite infestation?

Yes. There are 12 inspection holes in the steel sleeve where the intersection between the timber and the steel occurs. When supplied these holes are sealed from external water ingress with an industrial silicon sealant/adhesive. As part of the scheduled pole inspection regime throughout the poles service life these holes can be accessed for timber core sampling, plugged with preservative rods and capped, as per common pole inspection practices.

9. Will the steel corrode in the ground? How long does the hot dip galvanizing and ground line protection last?

It depends. The ground conditions are the key factor in how the steel performs in-ground. The base steel surface has been covered with two levels of protection. The first process is hot dip galvanizing (HDG) the entire steel section, to AS4680. The next level of protection Koppers have added to the KPOLE TSB is a coating of Zinga Liquid Galvanizing providing an additional galvanic protection and physical barrier to the poles critical zone, which is 500mm above and below the nominal ground line.

As with any steel buried in the ground, if there is a particularly acidic soil or a water table present, the loss of protection to the steel can be accelerated. In favourable conditions the steel will last beyond 75 years, before the corrosion gets to a critical point. However the ground conditions need to be considered when using this pole, with guidance given in the technical specifications for the product. If the soil is unfavourable the best option is a regular timber pole.

10. What makes KPOLE TSB design different to timber poles?

The KPOLE TSB is a certified engineer designed product using Reliability-Based Design (RBD) methods (Limit States Design) in accordance with the principles set out in AS1720.1 and AS4676 for the timber section and AS4100 for the steel section and therefore the capacities are also in accordance with the ENA C(b)1 guidelines for design.

The Design Capacity Tables provided by Koppers on request include the limit states capacities of regular timber poles and the KPOLE TSB so that an equivalent pole can be selected, or a pole simply selected to fit the calculated design loads.

With the push across the world to move to RBD rather than working stress design, and the complexity of applying working stress design to this product, Limit States Design was used in accordance with the relevant Australian Standard AS4676. This allows better consideration of the properties of the timber under different circumstances, better analysis of the loads on the structure, and hence a more reliable design.

11. Will the steel sleeve fill with water? If so, would that rust the inside of the pole?

Unlikely. The KPOLE TSB is completely sealed below ground with an 8mm base plate welded to AS/NZS1554, thereby preventing ground water ingress into the bottom of the steel sleeve. If condensate accumulates inside the steel sleeve this is expected to be minimal, and it is a very clean form of water. Condensate is managed through evaporation with a 75mm ventilation/inspection hole covered with a louvered vent and located below the end of the timber section. This ventilation hole allows for evaporation to occur and provides timber inspectors with a point of access for viewing the interior section of the pole. If corrosion does occur it is likely to be slower than the corrosion of the steel in the ground line area and is unlikely to govern the design life of the pole.

Strength group S2 hardwood is perfect round machined prior to CCA treatment to ensure a tight compression fit into the steel sleeve section.

12. What happens if the timber shrinks away from the inside of the sleeve?

This is likely to only be minimal. However, there is a minimum of 9 x 20mm coach screws to transfer vertical loads and maintain structural stability and continuity of the timber within the steel sleeve if the timber shrinks away from the inside of the steel sleeve. Integrity of the structural design was also tested using finite element analysis to confirm whether timber shrinkage causes small load application points on the sleeve that could cause high stresses. In this condition the pole design capacities were maintained.

13. What Ground Line Maintenance (GLM) is required over the KPOLE TSB's service life?

At a maximum Koppers recommends ground line and timber butt inspections after the first 7 years, then every 5-7 years after that. These should include the normal timber coring. The steel inspection should include digging to at least 300mm at 2 points around the ground line to expose and inspect the thickness of the Zinga coating. At every second or third inspection we would recommend digging to the bottom of the zinga coating to inspect the galvanizing below this point. The soil should be re-compacted when replacing. If severe loss of the coating (considered as 80% of the minimum thickness) is found it should be uncovered to the full extent of the loss, then repaired in accordance with the Zinga specifications. The interior of the steel and the butt of the timber can also be inspected by removing the vent hole cover and looking inside with a flexible boroscope.

The steel sleeve section is sealed with an 8mm base plate designed to support vertical compressive load, and to prevent the ingress of ground water and termites.

14. How does the KPOLE TSB perform with flashover and step/touch hazards?

Very well! The electrical performance of the KPOLE TSB will be equivalent to a timber pole for pole top leakages such as flashover. However, if the power line is to be earthed, we recommend the inclusion of a timber pole at this location, or the same method used to earth concrete or steel poles (i.e. Insulate the earth wire until it is a sufficient distance from the steel sleeve to prevent a step/touch hazard). Step/touch hazard may also be an issue with current in the ground passing the pole from further down the line. This should be addressed in the line design and is a site specific issue.

15. What is the service life expectancy of the KPOLE TSB?

>50 years (estimated). If regular inspection and maintenance is carried out on the poles – especially on the Zinga coating in the critical ground line area – the poles will be governed by the life of the regular HDG zinc coating:

The corrosion expert we used in the development of this product had the following comments in his reports;

"The galvanized coating life of the hot dip galvanized coating applied to the Koppers Steel Pole Sleeves, in other than marine exposure conditions should exceed 50 years and will more likely be in the order of 75 years, which is consistent with the large number of galvanized monopole structures installed throughout Australia" [Referring to the steel exposed to air]

"In power transmission applications, where steel pole sections are direct buried, the durability of the galvanized steel section below

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