COPPER-ZINC: SPECIFICALLY DESIGNED FOR USE IN MARINE AQUACULTURE

Copper is an essential micro-nutrient, helping achieve good health and development in all forms of life. The natural metallurgical and biological properties of copper alloys make them the perfect material for both surface and submersible marine aquaculture enclosures for near- and off-shore sites.

Technical Description
64% copper-zinc brass alloy containing 0.6% tin, 0.3% nickel and effective microelements. Currently this is the only copper alloy developed specifically for use in marine aquaculture. Copper-zinc's physical properties and inherent resistance to corrosion deliver an expected service life of approximately five years. Nets made from the 4 mm diameter wire have provided a service life of approximately four years in semi-protected sea conditions with up to 1.5 metre waves.

Alloy	Melting point (^{o}C)	Density (g/cm^{3})	Thermal Conductivity (cal/cm·sec·^{o}C)	Electrical Conductivity (%IACS)	Coefficient of Linear Expansion ($\times10^{-6}/^{o}$C)	Modulus of Elasticity (N/mm^{2})
UR30	920	8.4	0.28	26	21	1.03×10^{5}

Design and application considerations
Copper-zinc Ultra Resistant (UR) properties make it an ideal choice for aquaculture cages. Upon prolonged exposure to seawater, it forms an adherent protective oxide layer which naturally inhibits the attachment of fouling organisms, whilst increasing water flow and reducing opportunities for parasites and pathogens to grow and infect fish.

The alloy needs to be freely exposed and not coupled to galvanically less noble alloys or cathodically protected to achieve these properties. The overall result eliminates the need for labour-intensive maintenance procedures that can often produce significant waste.

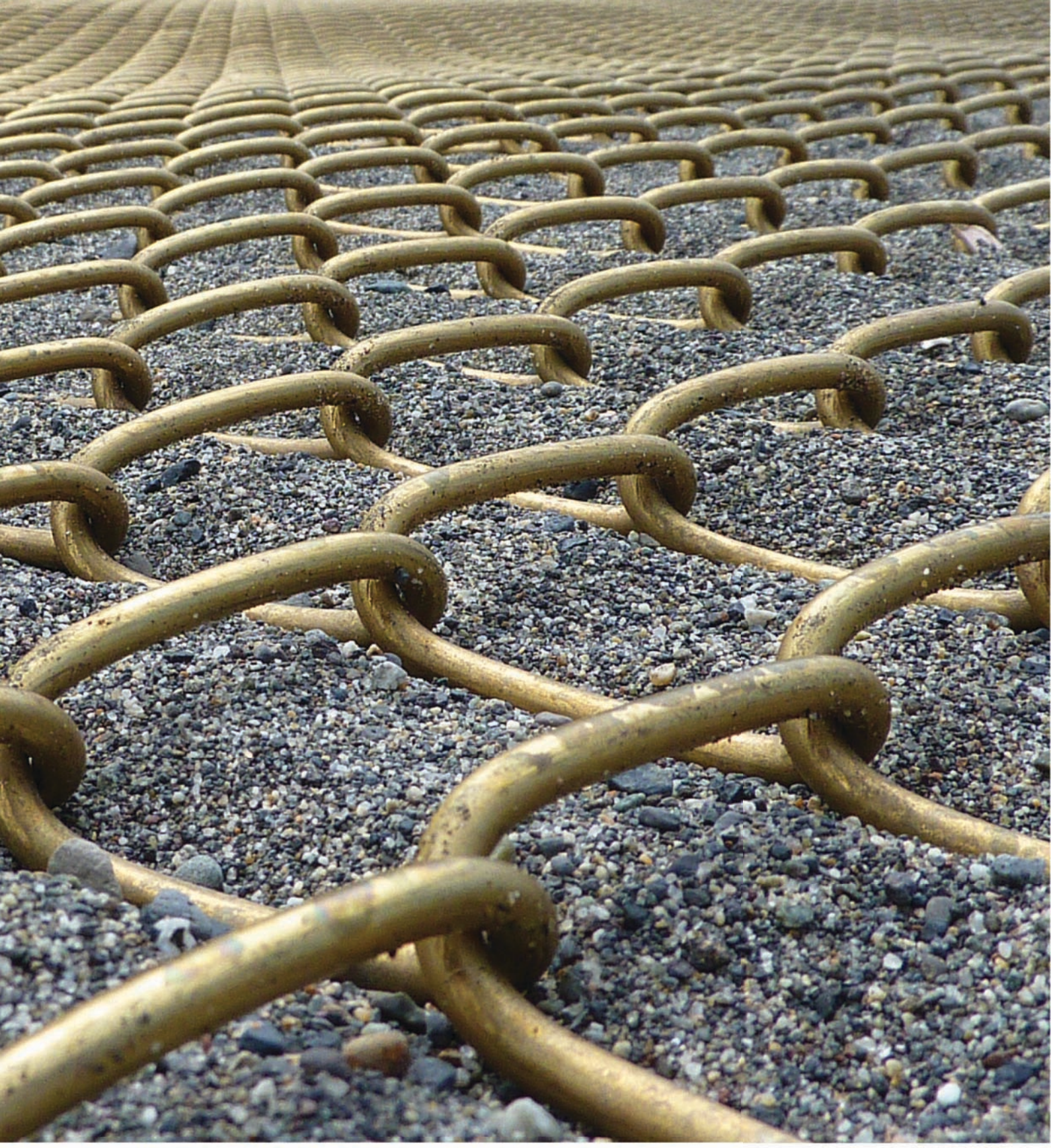
Copper-zinc also has high resistance to mechanical abrasion when formed into wires and fabricated into chain link, woven or other flexible meshes. It has an alpha single phase structure which makes it ductile and good for cold forming, enabling it to be installed on already-existing structures. Although it can be welded and brazed, the thermal effects can reduce the mechanical properties which are preferred in aquaculture applications. Typically twisted wire attachments are used. If the wire is welded, heat treatment is required to recover the original properties.

Copper-zinc is available in 44 mm wire chain link form with 40 mm square mesh opening and 2.5 mm wire in woven form with 25 mm square mesh opening. It also comes in bar, tube and sheet forms, making it a good material for various marine aquaculture applications including net pens, salmon hatcheries, filters for sanitizing recycled water in hatcheries, and antimicrobial copper surfaces for fish transport vessels.

Corrosion behaviour
The oxide surface film serves as protective barrier, resulting in good resistance to general thinning as well as localised and erosion corrosion. This also helps mesh and woven copper-zinc of the above composition resist mechanical abrasion. This brass alloy has not shown susceptibility to ammonia stress corrosion in aquaculture although, as with all copper alloys, exposure to polluted conditions containing ammonia and sulphides should be restricted wherever possible and particularly during the first few months of contact with seawater while the protective oxide film is maturing. The alloying content provides significant resistance to dezincification which some other brasses can be susceptible to. In fact, in over one decade of this copper-zinc's use in marine aquaculture, there have been no problems with dezincification, stress corrosion cracking or erosion corrosion.

Peak performance occurs at lower submersion points. Pilot tests demonstrate that mesh is more sensitive at approximately the first 200mm below the water line. The corrosion rate at the bottom of the nets is low: wire diameter decreases by less than 0.1mm/yr.

Galvanic Behaviour: Copper-zinc is more noble than steel and aluminium and if coupled to them requires to be electrically insulated from them (e.g. by non conducting gaskets, sleeves and washers)to maintain optimum biofouling resistance.



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