Conductor Facts

Lay Direction and Length

Stranded conductors are manufactured by twisting strands of un-insulated wire. The direction of the twists of the strands is designated as the "lay direction". The degree of twisting per unit length is the "lay length".

Lay Direction

The lay direction is determined by the direction the machine is turning during the stranding operation. The conventional method of determining the lay direction is to observe the upper surface of the stranded conductor with one end pointing toward yourself and the wire leading away from you:

If the individual strands on the layer leading away from the observer are pointing toward the left then that particular layer has a "left hand lay". The strands have the same slant as the middle of the letter "S", hence the other convention denoted as an "S" lay direction.

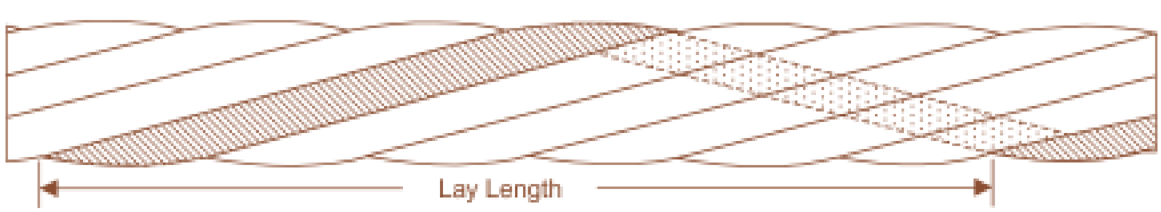
If the individual strands on the layer leading away from the observer are pointing toward the right then that particular layer has a "right hand lay". The strands have the same slant as the middle of the letter "Z", hence the other convention denoted as a "Z" lay direction.

Left Hand Lay or “S” direction

Right Hand Lay or “Z” direction

Lay Length

Lay length is defined as the distance required to complete one revolution of the strand around the diameter of the conductor.



When a conductor has more than one layer, it usually refers to the lay length of the outer layer. In the case of Unilay, Equilay and bunch, the lay length of all layers is equal. In True Concentric and Unidirectional, the lay lengths of the inner layers are less, this also holds true for rope constructions.

Fisk Alloy Conductors, Inc. • P.O. Box 26 • 10 Thomas Road • Hawthorne, NJ 07507 • U.S.A.
Phone (973) 427-7550 • Fax (973) 427-4585 • E-mail: sales@fiskalloy.com

Generally Accepted Practices

There are some general practices that pertain to the lay direction and lengths of conductor as specified by industry standards such as ASTM, NEMA and military, however, requirements for specific applications vary.

Outer Layer Lay Direction — the lay direction of the outer layer of strands or members is usually left. Inner layer directions depend upon the construction (True concentric, Unilay, etc).

Outer Layer Lay Length — the lay length of the outer layer of strands or members varies with different applications.

> For most conductor applications, lay lengths of between 8 - 16 times the outer diameter of a particular layer are specified by ASTM B 286. In general, lay lengths in the range of 12 -15 times the outer diameter are employed for tighter tolerance and geometric pattern control. Shorter lay lengths below 12 X have the disadvantage of slightly higher weight per unit length.
>
> For 7-strand and bunch applications, where tight diameter tolerance is less of a concern, lay lengths in excess of 30 times the outer diameter are common. Longer lay lengths are sometimes preferred by customers for cost, yield and weight considerations.

Stranding Factors

The increase in weight and resistance due to stranding can be mathematically calculated. ASTM refers to this increase as the stranding or "k factor", defined as the "percent incremental (increase) of weight and electrical resistance". ASTM B 8, B 229, B 231, et. al., give a method of calculating "*k*" as:

$$k = 100\ (m - 1)$$

Where:

k = incremental (increase) in weight and electrical resistance

m = the lay factor, the ratio of the mass or electrical resistance of a unit length of stranded conductor to that of a solid conductor of the same cross-sectional area or of a stranded conductor with an infinite length of lay (all wires parallel to conductor axis). The lay factor m for the completed stranded conductor is the numerical average of the lay factors for each of the individual wires in the conductor including the straight wire core, if any (for which the lay factor is unity).

The lay factor m_{ind}, for any given wire in a concentric-lay-stranded conductor is calculated as:

Where:

$$m_{ind} = \sqrt{1 + \left(\frac{9.8696}{n^2}\right)}$$

n = (length of lay) ÷ (diameter of helical path of the wire)

Example: the lay factor for a 19 strand conductor is the numerical average of all the 19 individual strands:

$$m = (1 + 6m_6 + 12m_{12}) \div 19$$

Where:

m_6 = the calculated m_{ind} for each of the 6 internal strands

m_{12} = the calculated m_{ind} for the 12 outer strands.