9.2.1 Cables in bundles

Fig. 9-9 shows various ways in which conductors or communication cables can be arranged in bundles. Two identical conductors can be twisted in pairs to avoid galloping (a). One or more carriers can be lashed onto a messenger (b). Two or more conductors can be used in a bundle. For bundles of two conductors, a horizontal configuration (c) or a vertical configuration (d) can be used. Insulated conductors can be supported by a messenger and maintained a certain distance apart (e).

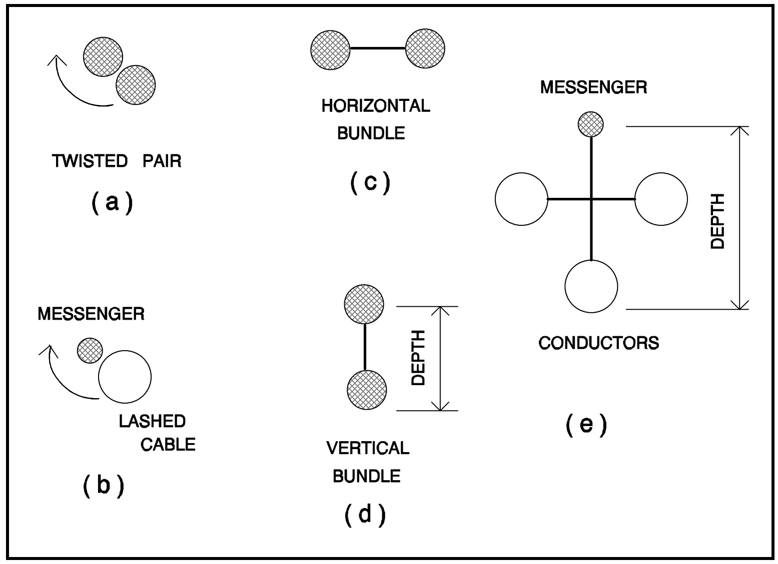

Fig. 9-9 Cables in bundles

In the various applications described in Fig. 9-9, the stressed cables (which determine sags and pass loads to the supporting structures) are shown as greyed circles. Supported cables that only contribute weight, wind and ice loads to the system, but are not subjected to tension, are shown as open circles.

In order that **PLS-CADD** correctly model unit conductor loads (weight, wind and ice) and correctly predict sags and structure loads in bundle situations, it is important that you understand what input properties should be used in the **Cable Data** dialog box of Fig. 9-6 and what *Number of Conductors Per Phase* should be used in the **Section Modify** dialog box of Fig. 10.3-3.

9.2.1.1 Twisted pairs (Fig. 9-9-a)

Cross section area, AT: Twice cross section area of single subconductor

Outside diameter, D: Because the diameter exposed to the wind changes continuously along the conductor, an average equivalent circular diameter equal to 1.64 times the subconductor diameter can be used (Roche, J.B. et al., "T2 Wind Motion Resistant Conductor", IEEE Transactions on Power Apparatus and Systems, Vol. PAS-104, No. 10, Oct. 1985).

	According to the reference, the equivalent diameter will also provide a good estimate of ice load based on ice thickness.
Unit weight, UW:	Twice unit weight of single subconductor
Ultimate tension, ULT:	Twice ultimate tension of single subconductor
Number of independent cables, N:	One
Stress-strain and other properties:	Same as those for single subconductor

Number of conductors per phase: One

9.2.1.2 Lashed cable onto a messenger (Fig. 9-9-b)

Cross section area, AT:	Cross section area of messenger
Outside diameter, D:	Because the diameter exposed to the wind changes continuously along the conductor, an average equivalent circular diameter should be used. That equivalent diameter will be used to determine the ice load based on ice thickness.
Unit weight, UW:	Total unit weight of messenger plus supported cable
Ultimate tension, ULT:	Ultimate tension of messenger
Number of independent cables, N:	One
Stress-strain and other properties:	Properties of messenger

Number of conductors per phase: One

9.2.1.3 Conductor bundles (Fig. 9-9-c and d)

Cross section area, AT:	Cross section area of single subconductor
Outside diameter, D:	Diameter of single subconductor
Unit weight, UW:	Unit weight of single subconductor
Ultimate tension, ULT:	Ultimate tension of single subconductor
Number of independent cables, N:	One
Stress-strain and other properties:	Properties of single subconductor

Number of conductors per phase: Actual number of subconductors (2 for examples in Fig. 9-9-c and d)

Special consideration for depth of bundle:

You should take into account the vertical dimension of the bundle (DEPTH in Fig. 9-9-d) when checking vertical clearance. This can be done by lowering the bundle attachment point by the length DEPTH (for example by using longer suspension insulators) or increasing the required vertical clearance by that amount.

9.2.1.4 Spaced conductors supported by messenger (Fig. 9-9-e)

Cross section area, AT:	Cross section area of messenger
Outside diameter, D:	Equivalent diameter equal to the sum of the diameters of all the cables in the bundle (diameter of messenger plus 3 times diameter of conductors for situation in Fig. 9-9-e).
Unit weight, UW:	Total unit weight of messenger plus supported conductors
Ultimate tension, ULT:	Ultimate tension of messenger
Number of independent cables, N:	Number of spaced cables in bundle (4 for situation in Fig. 9-9-e). This number is used internally for the calculation of ice and wind-on-ice loads which take into account the fact that each cable in the bundle is subjected to a coating of uniform ice thickness
Stress-strain and other properties:	Properties of messenger

Number of conductors per phase: One

Special consideration for depth of bundle:

You should take into account the vertical dimension of the bundle (DEPTH in Fig. 9-9-e) when checking vertical clearances. This can be done by lowering the bundle attachment point by the length DEPTH (for example by using longer suspension insulators) or increasing the required vertical clearance by that amount.