STANLEY®
Engineered Fastening

HELI-COIL®
Tensile Strength of Threaded Insert Assembly

Metric Series

Technical Bulletin PP-15

HeliCoil®

TENSILE STRENGTH OF HELI-COIL® INSERT ASSEMBLIES – METRIC SERIES

The purpose of this Bulletin is to furnish all necessary information and data on the strength of Heli-Coil® Insert assemblies.

The subject of threaded insert assembly strength has been somewhat confusing to the product designer due to the various claims of insert manufacturers and their respective methods of publishing data. While some manufacturers advise what tensile strengths are achieved in a few sizes in certain materials, others show what insert nominal length is required to achieve the full bolt strength. In either case, the designer cannot easily compare the assembly strength of the various types of inserts, nor can he readily determine the actual tensile strength for every size and length.

The graph method of presenting this data as employed in this Bulletin is easy to use and provides the greatest degree of flexibility. The four varibles shown on the graphs are:

1. Tensile strength of the insert assembly (kilonewtons).
2. Insert length in terms of the nominal thread diameter.
3. Shear strength of typical parent materials (megapascals).*
4. Tensile strength of common bolts (kilonewtons & megapascals).**

Examples of the various ways that these graphs can be used are:

1. Assume that an M6x1 is to be designed in 6061-T6 Aluminum of 207 MPa shear strength. What is the insert length required to support a 22 kN load, and what strength screw is required?

   On the M6x1 graph find the vertical line for 207 MPa shear strength parent material. The insert nominal length lines intersect this vertical line for 1 Diameter inserts at 15.5 kN, for 1.5 Diameter inserts at 25.5 kN, and for 2 Diameter inserts at 36 kN, (these values for insert assembly strengths are listed on the left side of the graph). On the right side of the graph, notice that the bolt material ultimate tensile strengths are shown and are directly convertible to kilonewtons shown on the left side. It can be concluded that for M6x1 in 207 MPa parent material, a 1.5 Diameter insert length and a 1220 MPa bolt will safely support the 22 kN load. Note that the safety factor also can be easily calculated from the data available in these graphs.

2. Assume that the M6x1 bolt is known to be 900 MPa ultimate tensile strength and the parent material is 356-T6 Aluminum of 179 MPa shear strength. What insert length is required?

   Starting at the right side at the 900 MPa bolt ultimate tensile strength level, move horizontally to the left to the point of intersection with the vertical line at 179 MPa of the parent material shown on the bottom of the graph. The 1 Diameter rating of 13 kN is not strong enough to sunport the full tensile rating of the bolt which is 18 kN. In this material, the 1.5 Diameter insert achieves a tensile strength of 22 kN and if adequate material thickness is available, this is the insert which should be used to provide a safety margin.

It is necessary for the designer to know only two of the four variables, and with the aid of these graphs the other two variables are easily determined. Another use of these graphs is to aid in selecting the combinations of thread size and bolt material which are possible when the designer knows the load, in kilonewtons, and the parent material shear strength in megapascals. For example,

1. Assume an assembly strength of 40 kN is required and the 16 mm thick parent material shear strength is 160 MPa.
2. Examining graphs for several sizes it is concluded:
   a) M6x1: The 2.5 Diameter long inserts and the 1800 MPa bolts are not adequate because they both have an ultimate tensile strength of only 36 kN.

b) M7x1: The 1800 MPa bolts are acceptable, but we do not have sufficient parent material thickness to accept the 2.5 Diameter length insert.
c) M8x1.25: A 2 Diameter insert and a 1220 MPa bolt will suffice.
d) If 830 MPa bolts are desired, an M10x1.5, 1.5 Diameter long insert would be required.
e) If a 520 MPa bolt is desired, then an M12x1.75, 1 Diameter long insert would be adequate for this application.

As shown by the above listed possibilities, the designer is afforded a great degree of flexibility vlith regard to selection of insert sizes, lengths and bolt strengths, consistent with space availability and hardware cost. Another factor to consider is that it is consistent with good design practice to select insert lengths which provide assembly strengths greater than that of the screw, because if excessive torque is applied to the screw it should fail before the insert assembly.

An important factor which must be considered by the designer is that the shear strength of the parent materials shown in these graphs are for room temperature only. At elevated temperatures, the shear strength of most light metals is decreased rather significantly, and the designer should consult a metals handbook to determine the actual shear strength at temperature.

For insert sizes or lengths not included herein, or for special bolt or parent materials outside the range of these graphs, please consult with a Heli-Coil Applications Engineer.

*Shear strength values shown on these charts are average values. The engineer may wish to base his design on minimum, or some other, intermediate value. MIL-HDBK-5A is recommended as an excellent source for complete data on metallic materials.

**Tensile strengths of common bolts as shown on these charts are the minimum strengths as specified on the applicable covering specification. The actual tensile strength of any particular bolt will most usually be greater than these minimvalues.

APPENDIX

CONVERSION

Metric (SI) units, which are used throughout this Standard, are in accordance with ASTM E380-76, STANDARD FOR METRIC PRACTICE. For convenience, conversion factors between these and customary (English Imperial) units are shown below:

To Convert From	To	Multiply By
kilonewton (kN)	pound-force	2.248089×10^{2}
Pound-force (lb-f)	kilonewton	4.448222×10^{-3}
kilonewton (kN)	newton (N)	1000
megapascal (MPa)	pounds per sq sq inch	1.450377×10^{2}
pounds per sq inch (psi)	megapascal	6.894757×10^{-3}
megapascal (MPa)	newton/sq millimeter (N/mm)	1.000000

FORCE, MASS and WEIGHT

The concept of FORCE, MASS and WEIGHT merits some discussion. One of the principal departures of the (metric) SI system is its use of explicitly distinct units for MASS and FORCE.

FORCE is the “push” or “pull” that may be exerted on a body. A railroad locomotive exerts FORCE on the cars behind in order to move them. FORCE is exerted on the wings of an airplane to lift and keep the airplane off the ground. When a bolt is tightened, its head exerts FORCE on the·part upon which it bears. The unit of FORCE in SI is the newton (N).

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MASS is the absolute amount of matter contained in a body and is independent of outside force effects such as gravity. The kilogram (kg) (1000 grams) is the basic unit of MASS in SI. One kilogram of MASS is the same whether it is measured on Earth, on the Moon or in a space capsule somewhere between.

WEIGHT, unlike MASS, is not absolute since it is the pull that gravity exerts on a body, and gravity differs even between places on the surface of the Earth (by as much as 0.5%), and in space there is no force of gravity. At sea level on Earth, WEIGHT is to all intents and purposes the same as MASS, and its unit of measure is the kilogram (kg). When a person steps on a scale, the scale tells his weight in kilograms, which is the FORCE of gravity acting on his body. But since gravity is a FORCE and FORCE is measured in newtons, there must be an numerical relationship between WEIGHT in kilograms and FORCE in newtons. This relationship is:

9.806650 newtons = 1 kilogram.

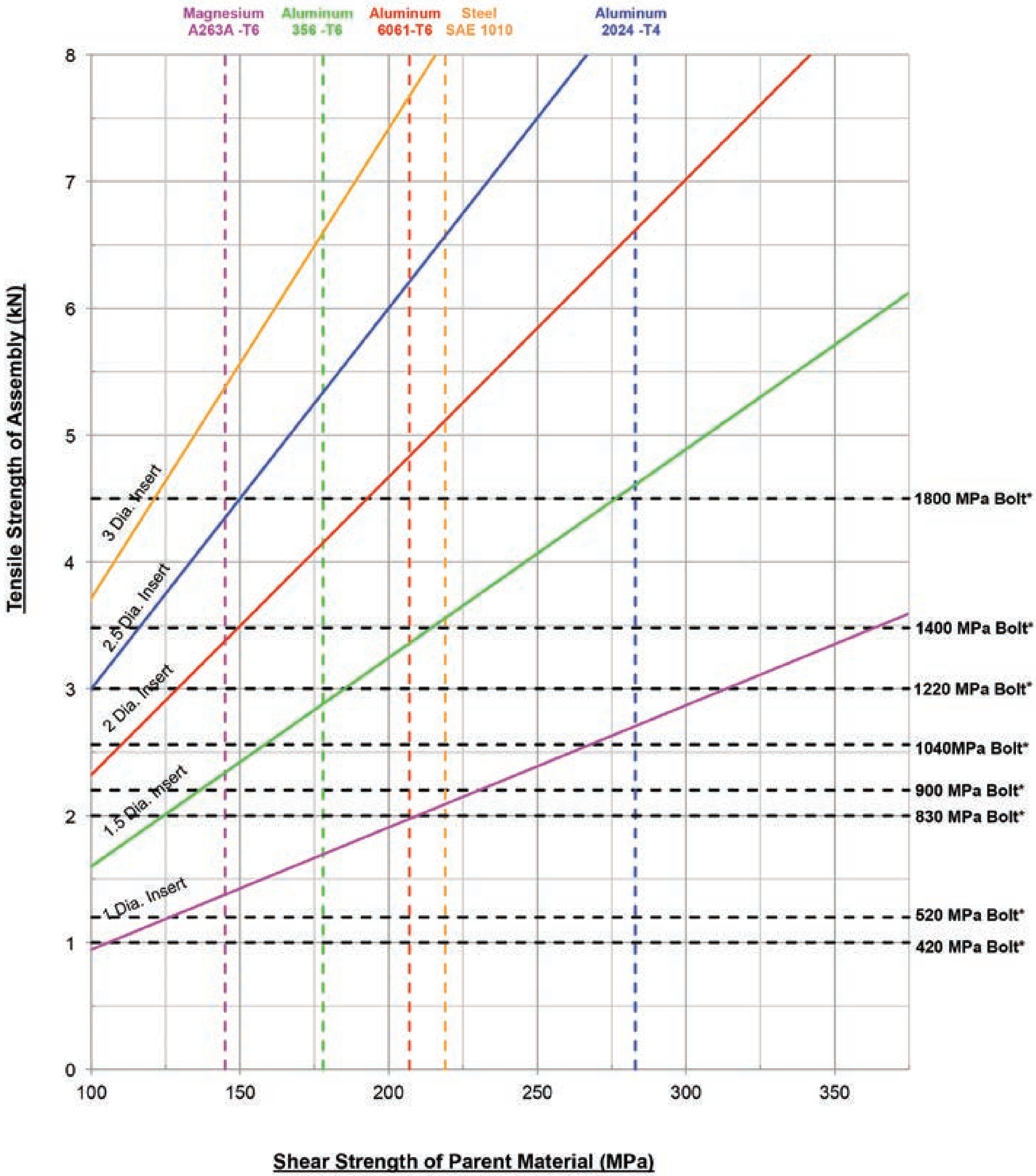
Therefore, when this person steps on a scale and the scale reads 70 kilograms the scale is actually telling him that 686.5 newtons (70 x 9.806650) of gravitational force is acting on his body. Then, if the scale is suspended from a bolt in the ceiling, that bolt is loaded by a force of 686.5 newtons (.6865 kilonewtons). Bolt load, in kilonewtons, is one of the functions shown on the graphs in this Bulletin.

When needed, the conversion between force (newtons)and mass (kilograms) is:

To Convert From	To	Multiply By
kilogram (kg)	pound-mass (weight)	2.204622
pound-mass (weight)	kilogram (kg)	4.535924 X 10^{-1}
newton (force)	kilogram (mass or wt)	1.019716 X 10^{-1}
kilogram (mass or wt)	newton (force)	9.806650

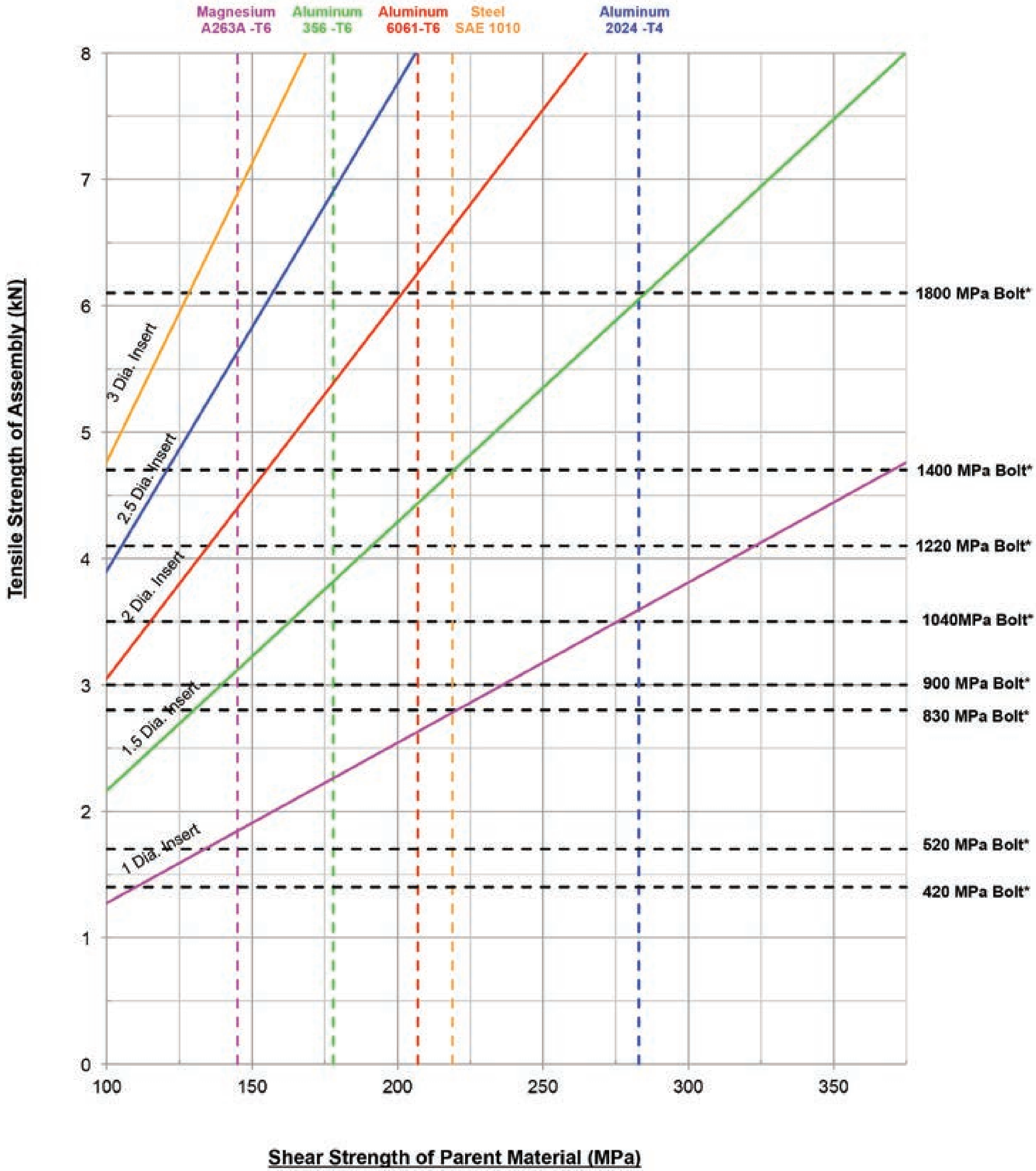
Tensile Strength of Heli-Coil Assembly vs. Shear Strength of Parent Material for M2.2x0.45 Size

(*) Bolt Material Ultimate Tensile Strength



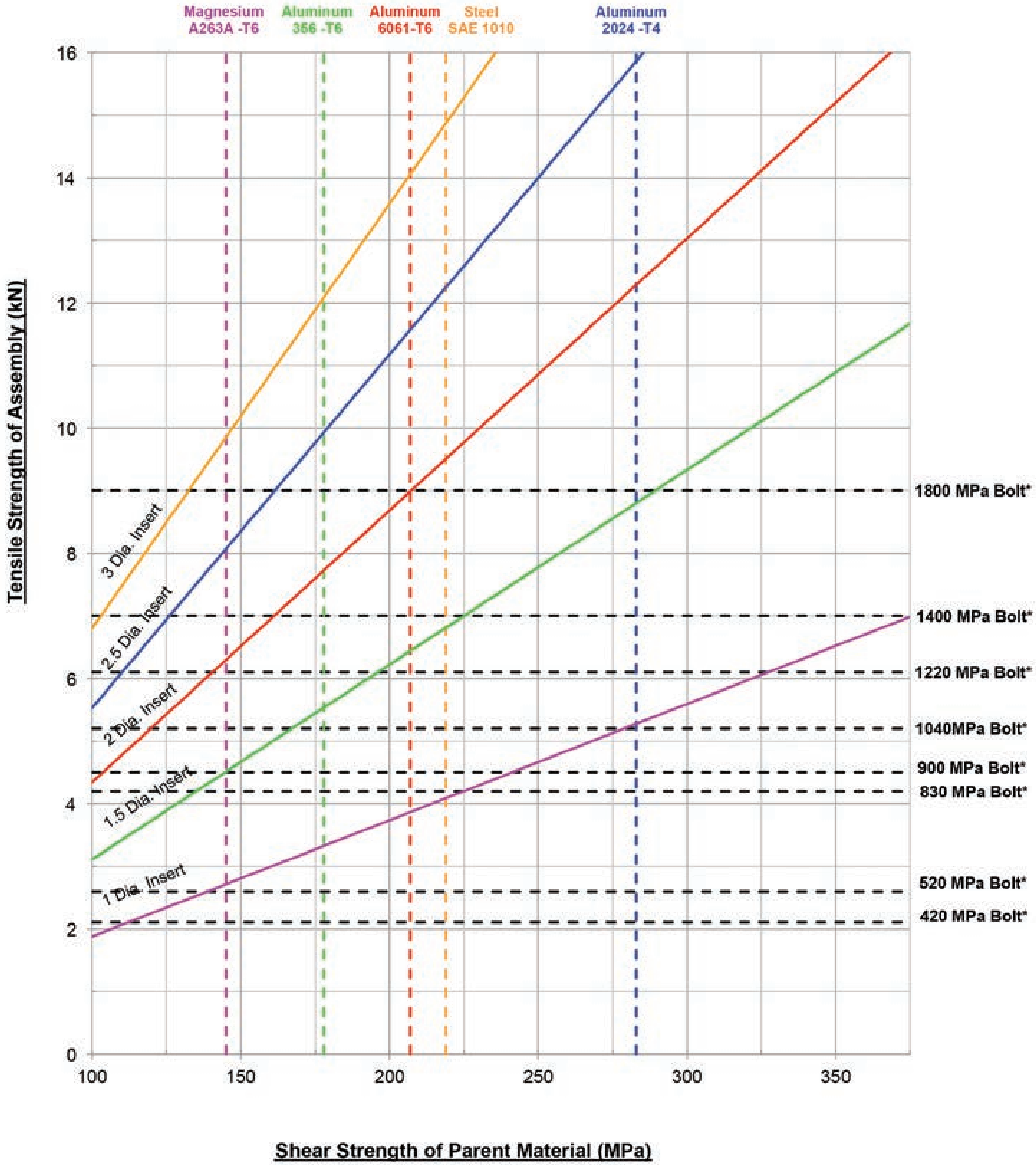
Tensile Strength of Heli-Coil Assembly vs. Shear Strength of Parent Material for M2.5x0.45 Size

(*) Bolt Material Ultimate Tensile Strength



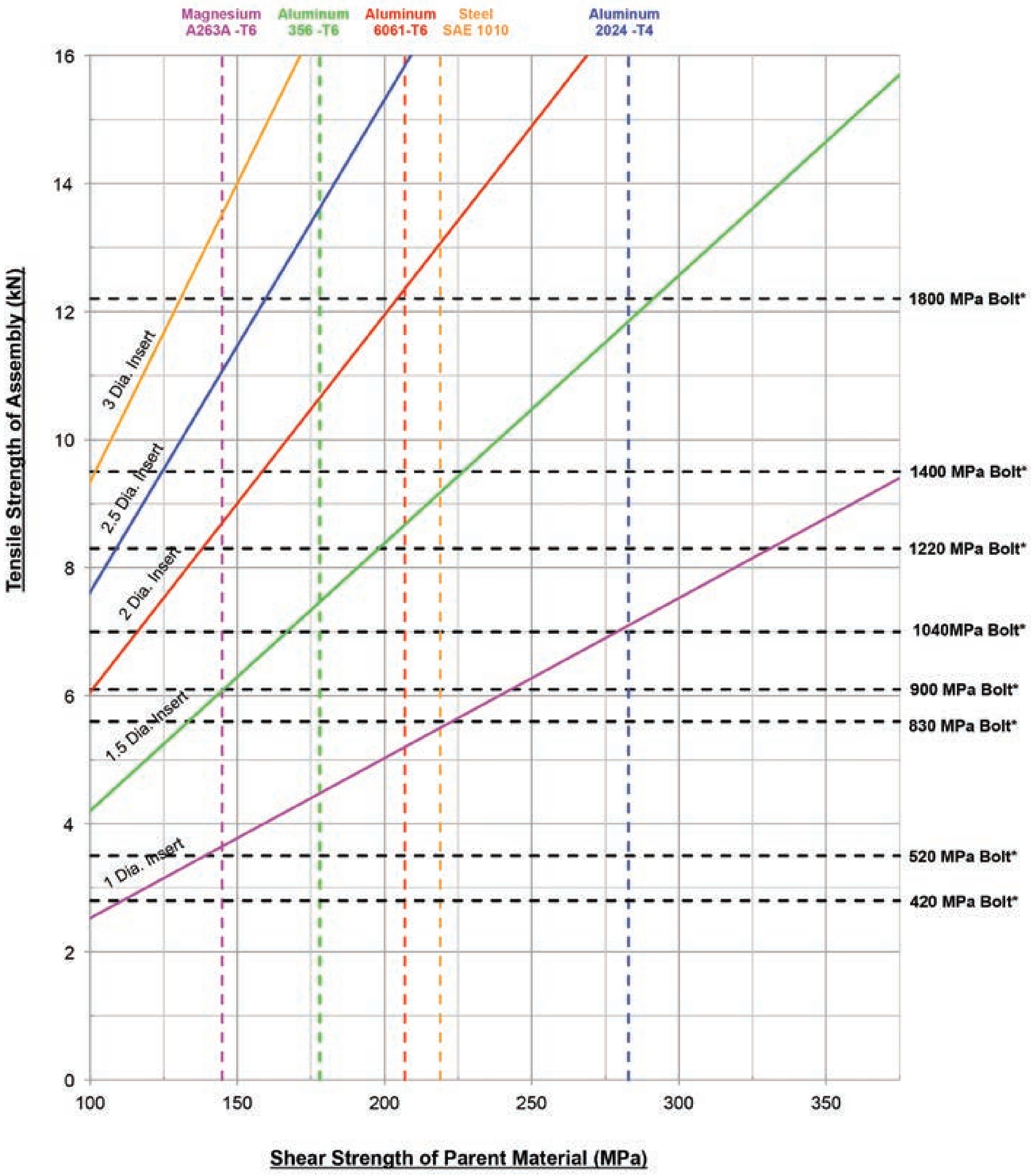
Tensile Strength of Heli-Coil Assembly vs. Shear Strength of Parent Material for M3x0.5 Size

(*) Bolt Material Ultimate Tensile Strength



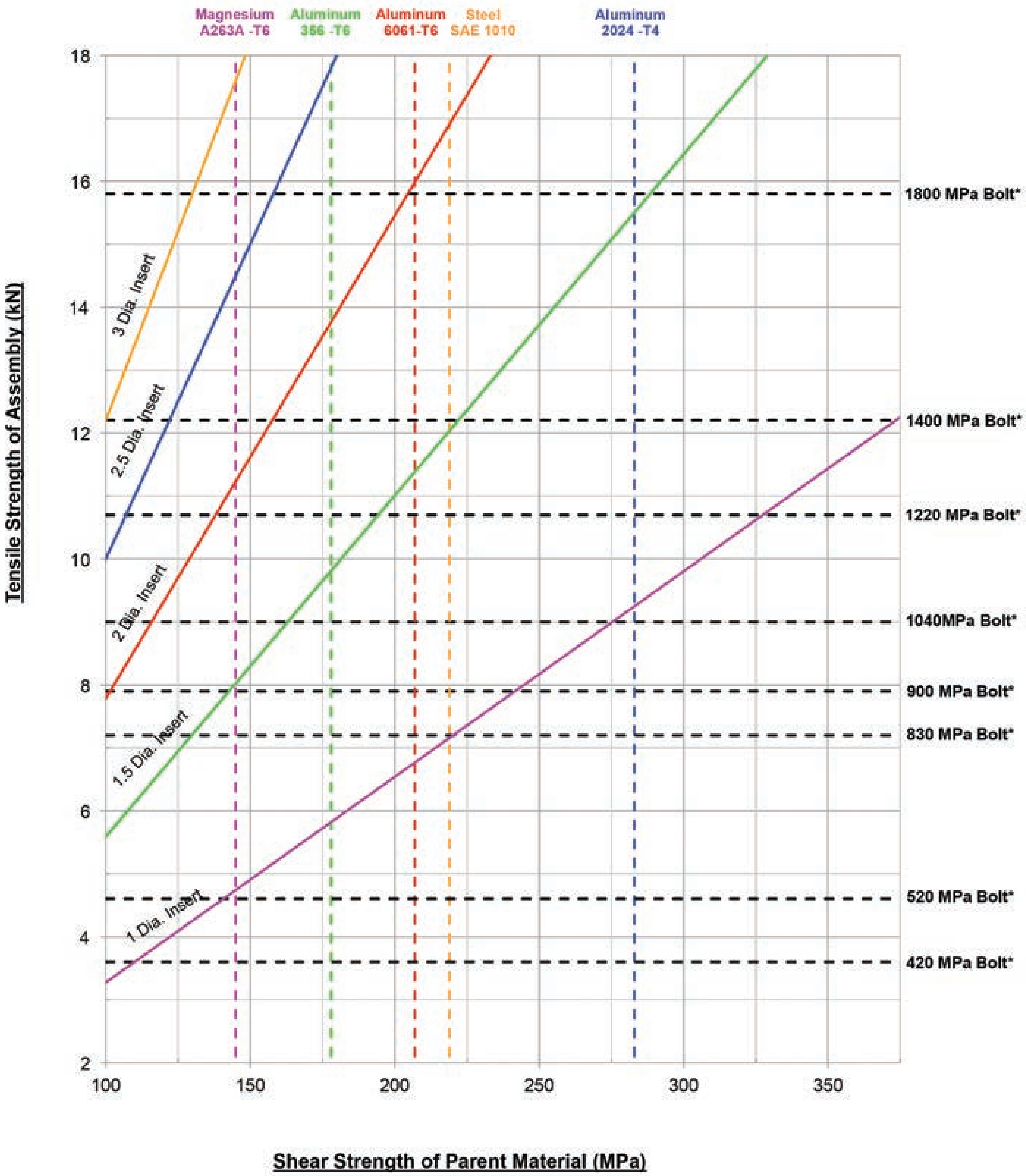
Tensile Strength of Heli-Coil Assembly vs. Shear Strength of Parent Material for M3.5x0.6 Size

(*) Bolt Material Ultimate Tensile Strength



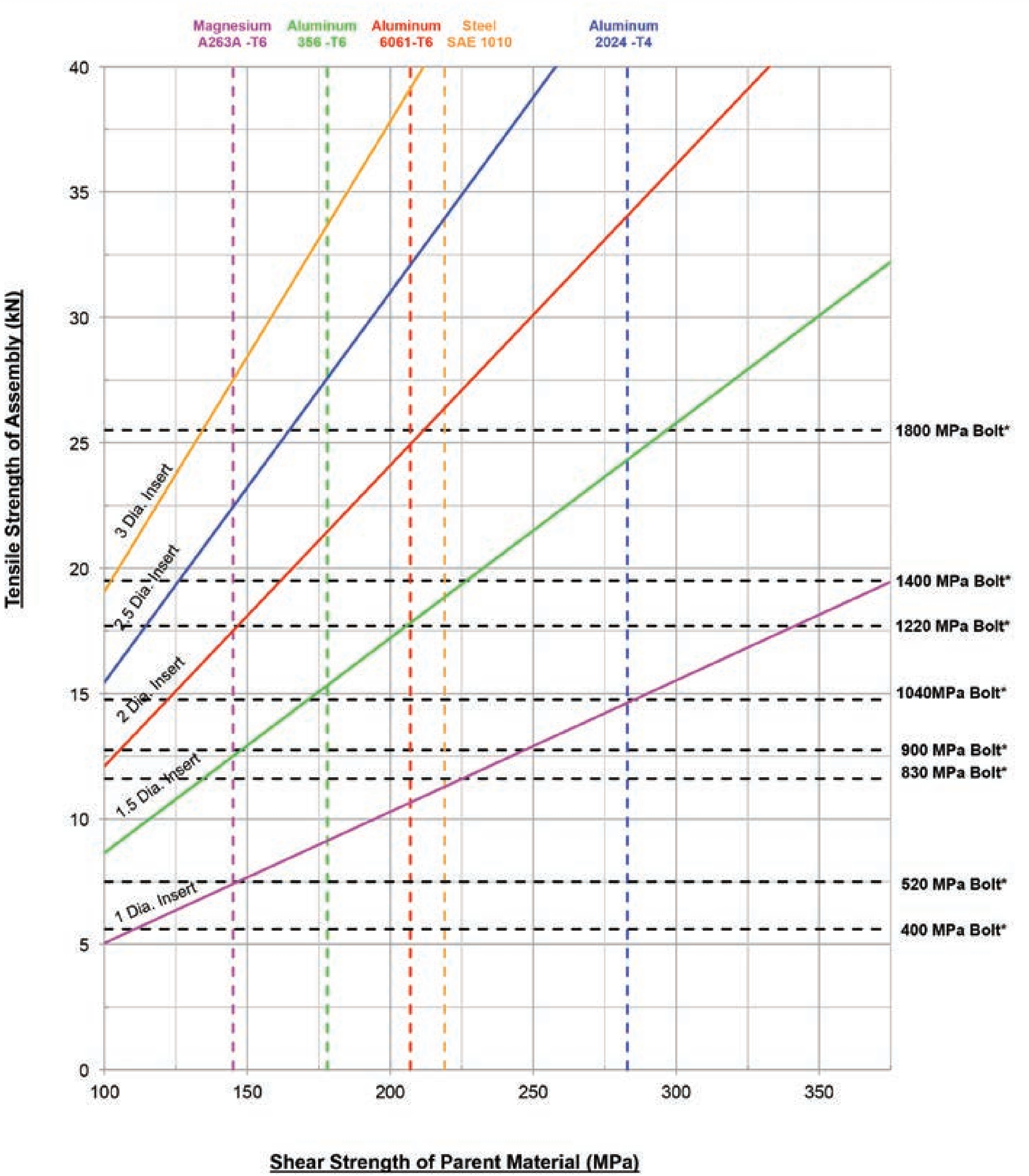
Tensile Strength of Heli-Coil Assembly vs. Shear Strength of Parent Material for M4x0.7 Size

(*) Bolt Material Ultimate Tensile Strength



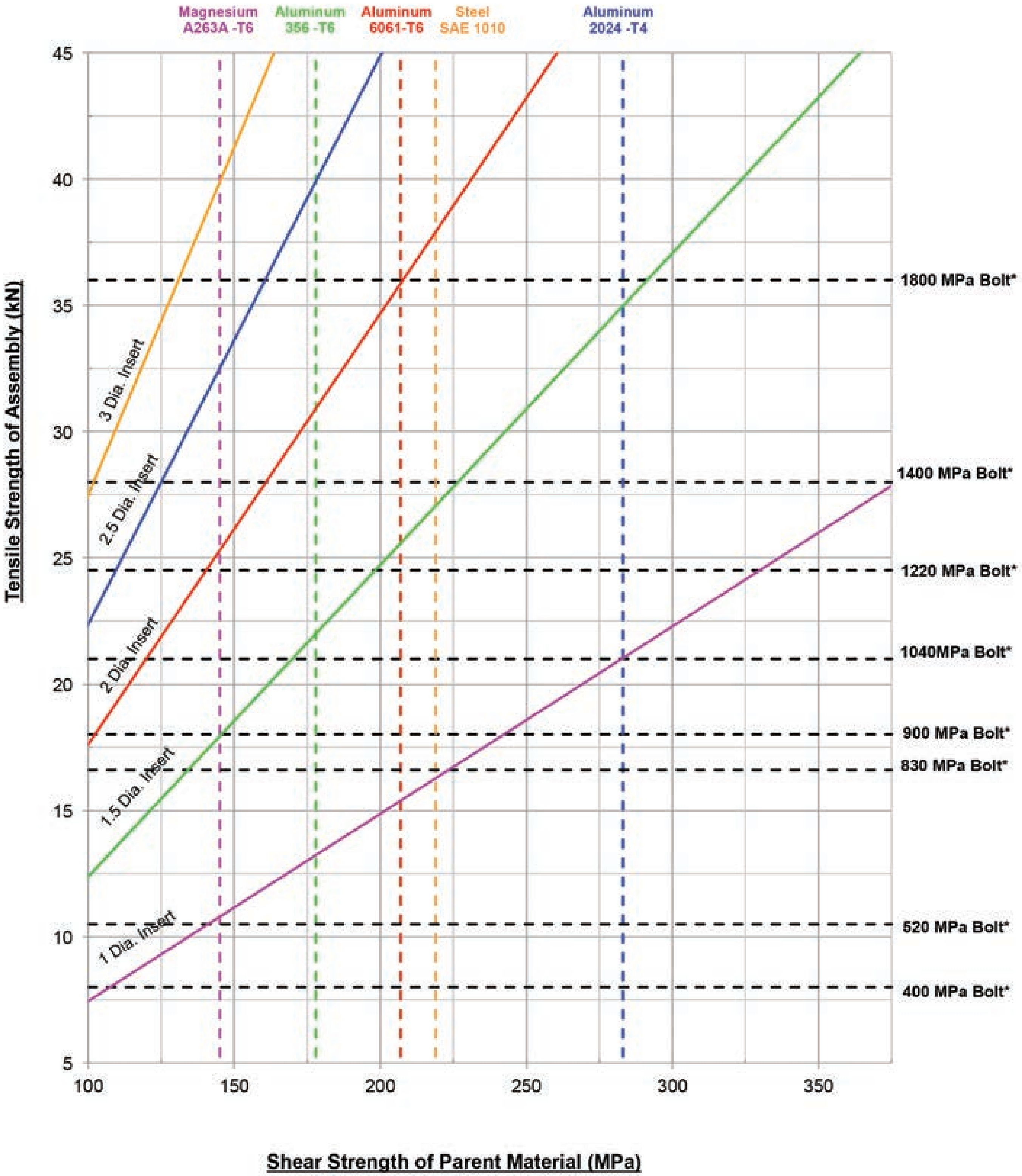
Tensile Strength of Heli-Coil Assembly vs. Shear Strength of Parent Material for M5x0.8 Size

(*) Bolt Material Ultimate Tensile Strength



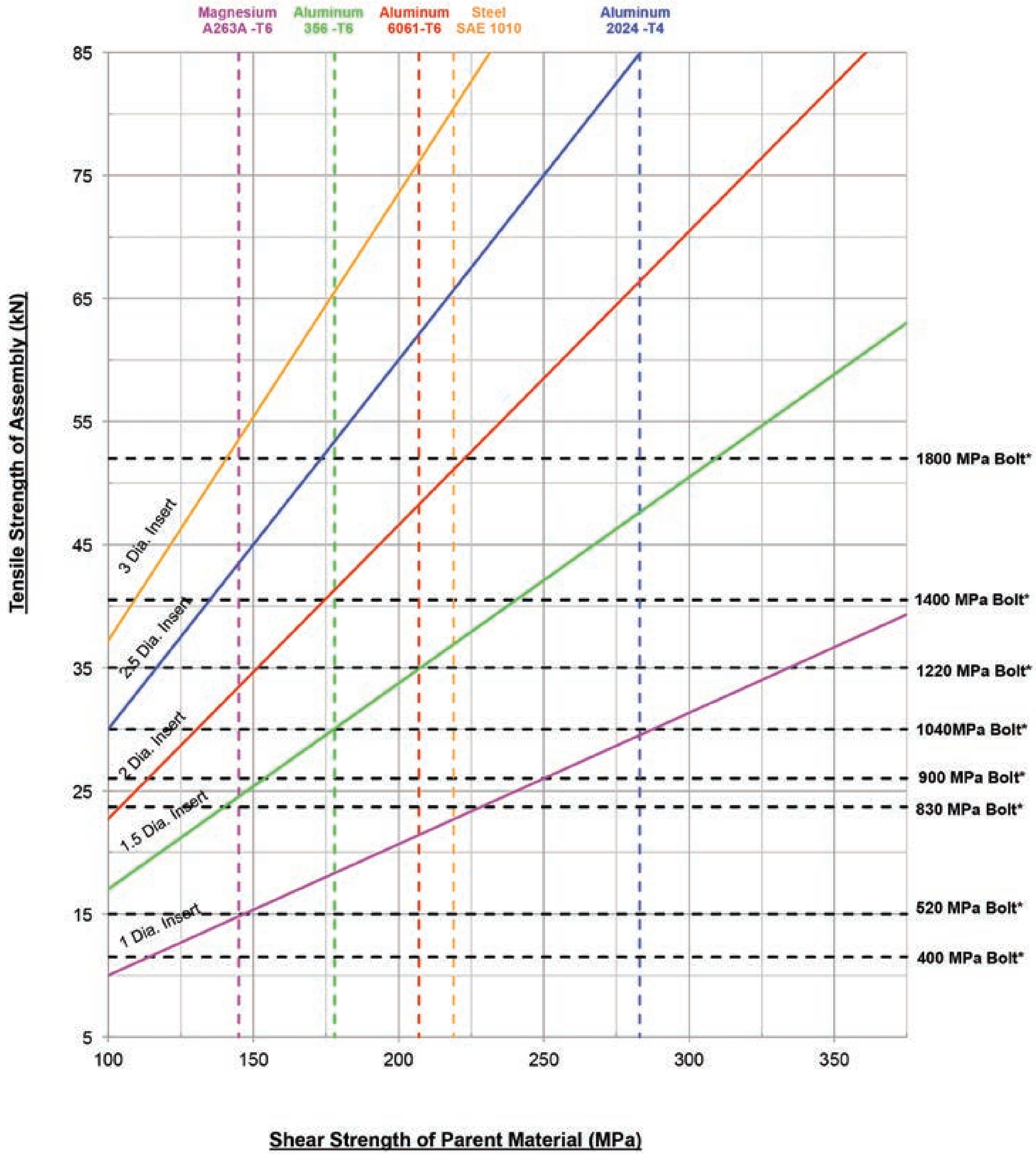
Tensile Strength of Heli-Coil Assembly vs. Shear Strength of Parent Material for M6x1 Size

(*) Bolt Material Ultimate Tensile Strength



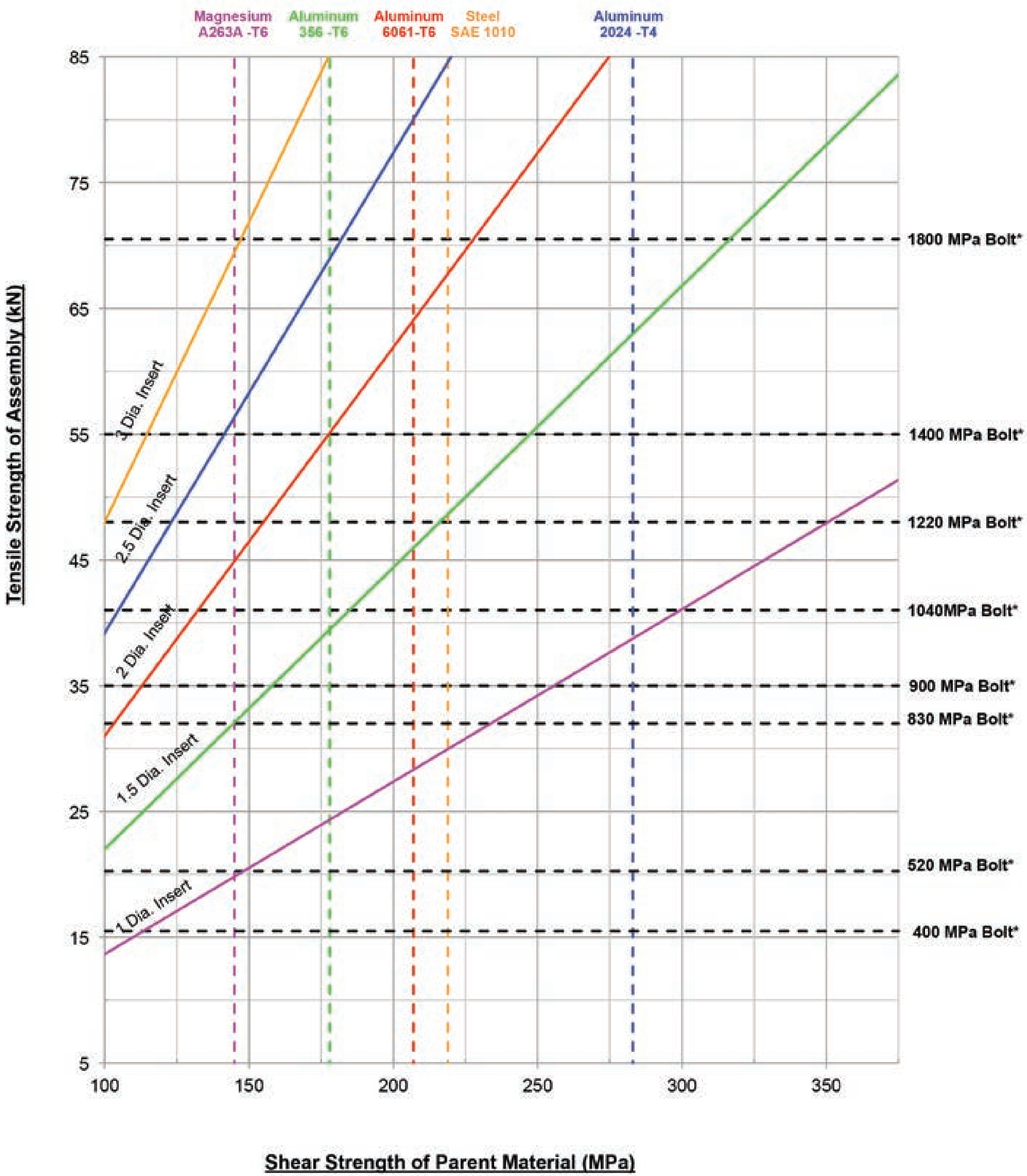
Tensile Strength of Heli-Coil Assembly vs. Shear Strength of Parent Material for M7x1 Size

(*) Bolt Material Ultimate Tensile Strength



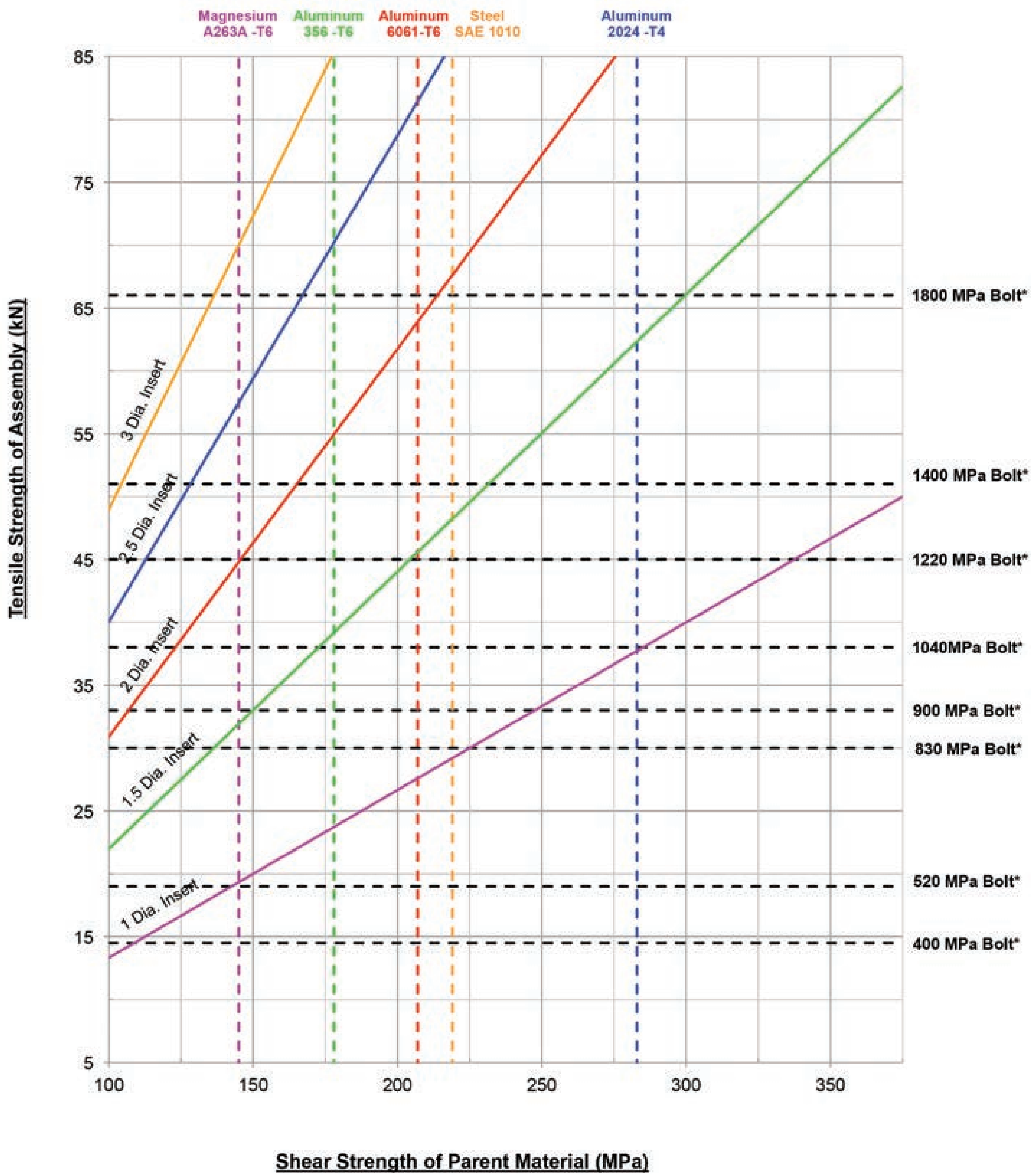
Tensile Strength of Heli-Coil Assembly vs. Shear Strength of Parent Material for M8x1 Size

(*) Bolt Material Ultimate Tensile Strength



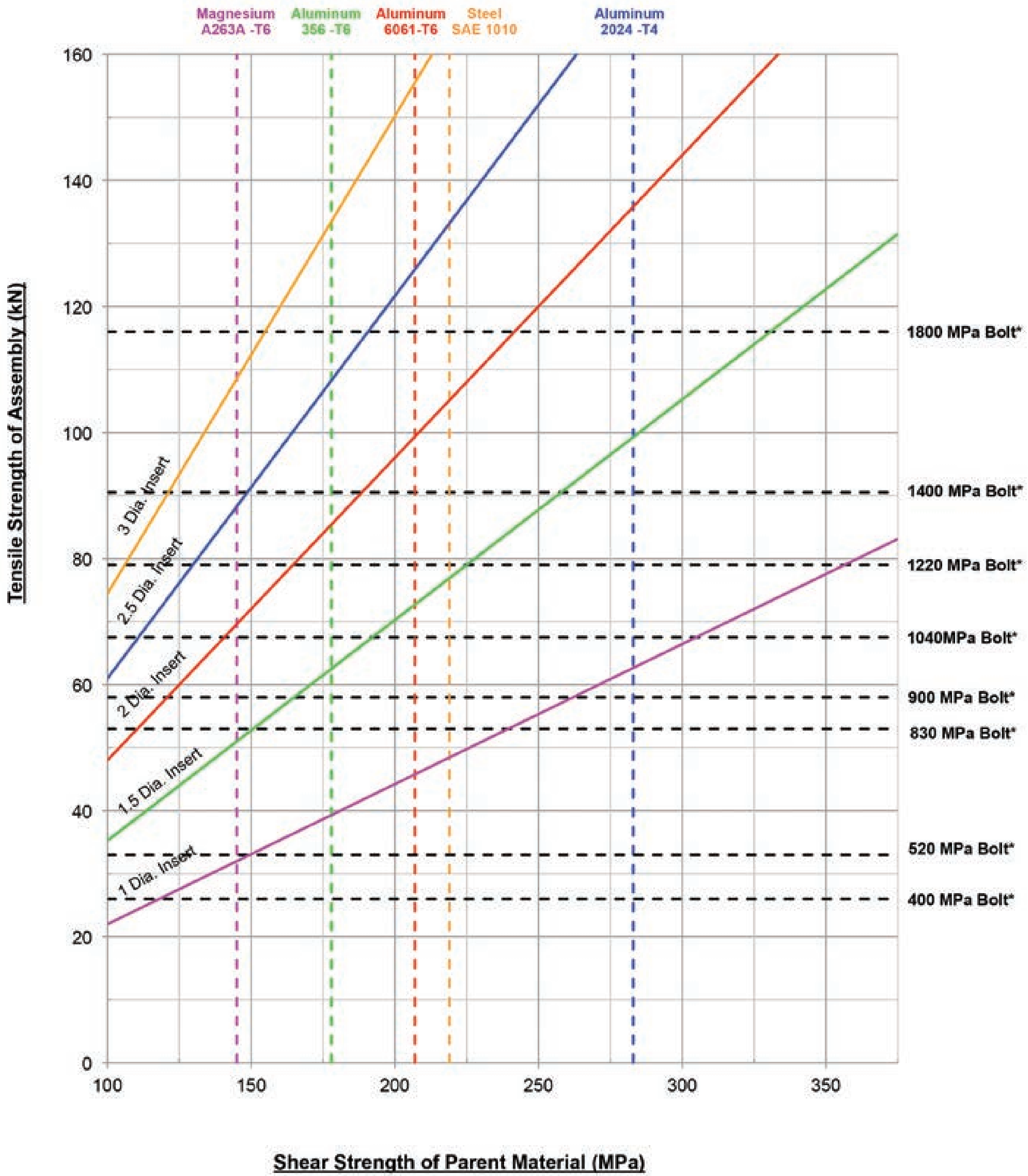
Tensile Strength of Heli-Coil Assembly vs. Shear Strength of Parent Material for M8x1.25 Size

(*) Bolt Material Ultimate Tensile Strength



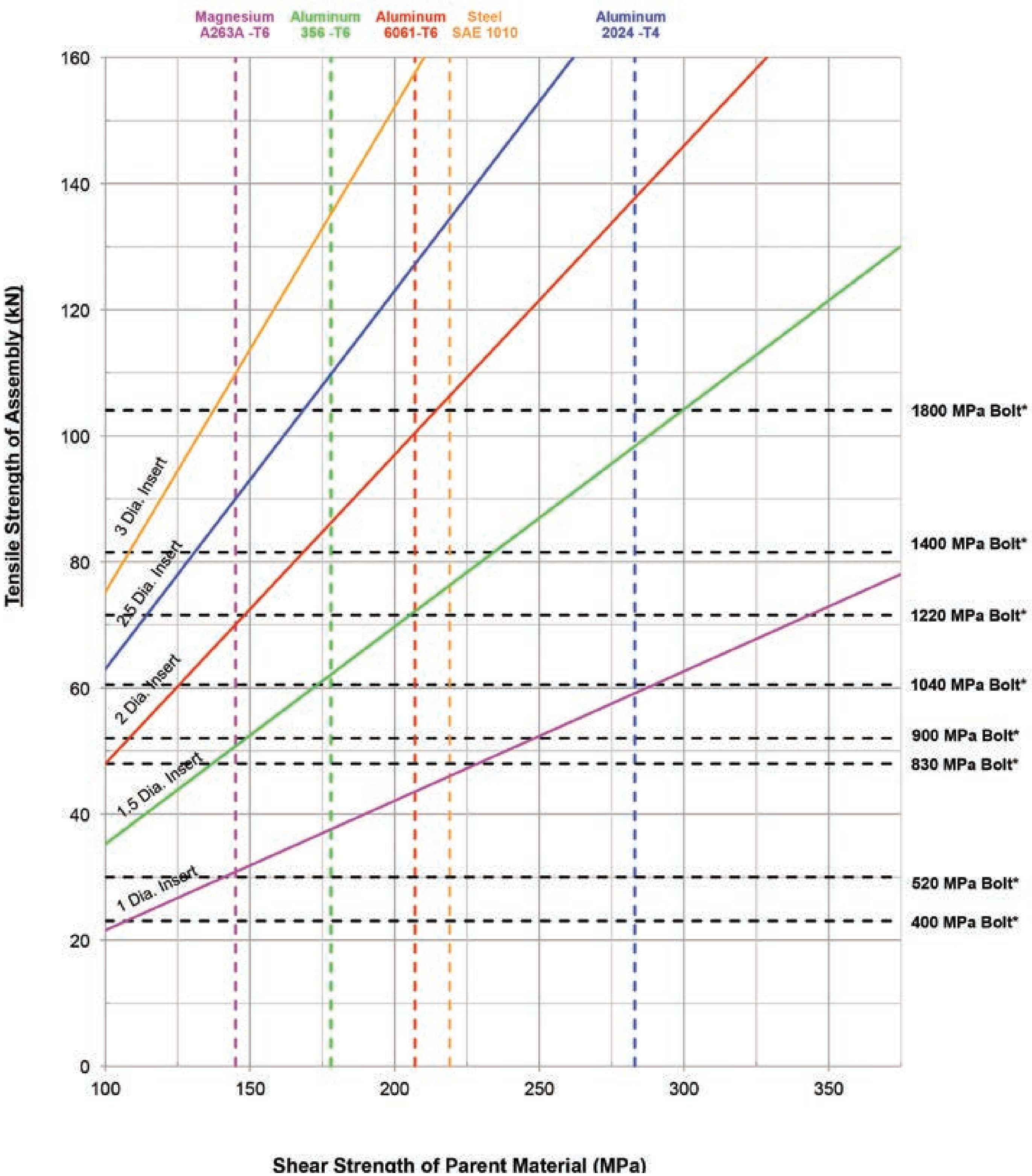
Tensile Strength of Heli-Coil Assembly vs. Shear Strength of Parent Material for M10x1 Size

(*) Bolt Material Ultimate Tensile Strength



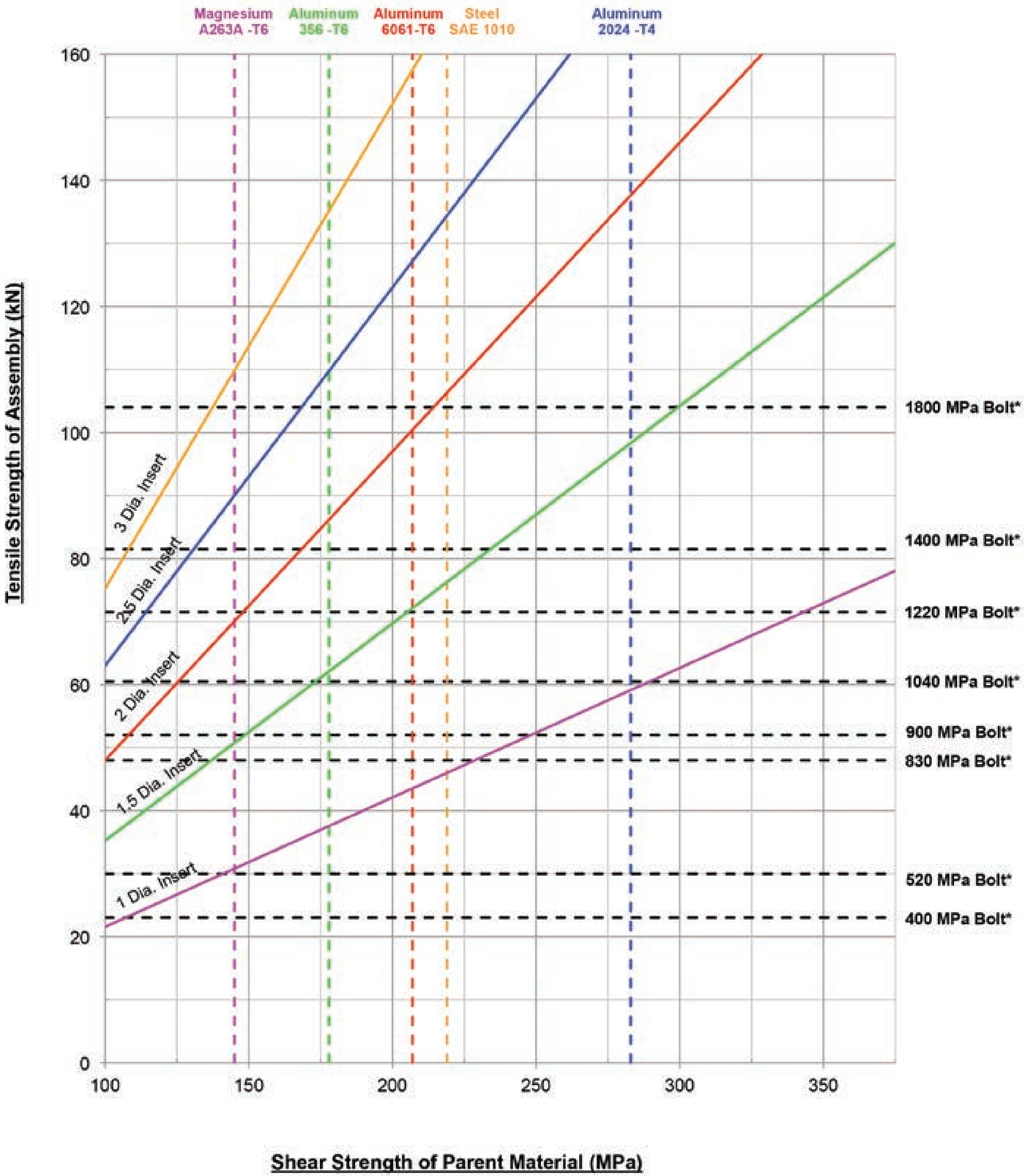
Tensile Strength of Heli-Coil Assembly vs. Shear Strength of Parent Material for M10x1.25 Size

(*) Bolt Material Ultimate Tensile Strength



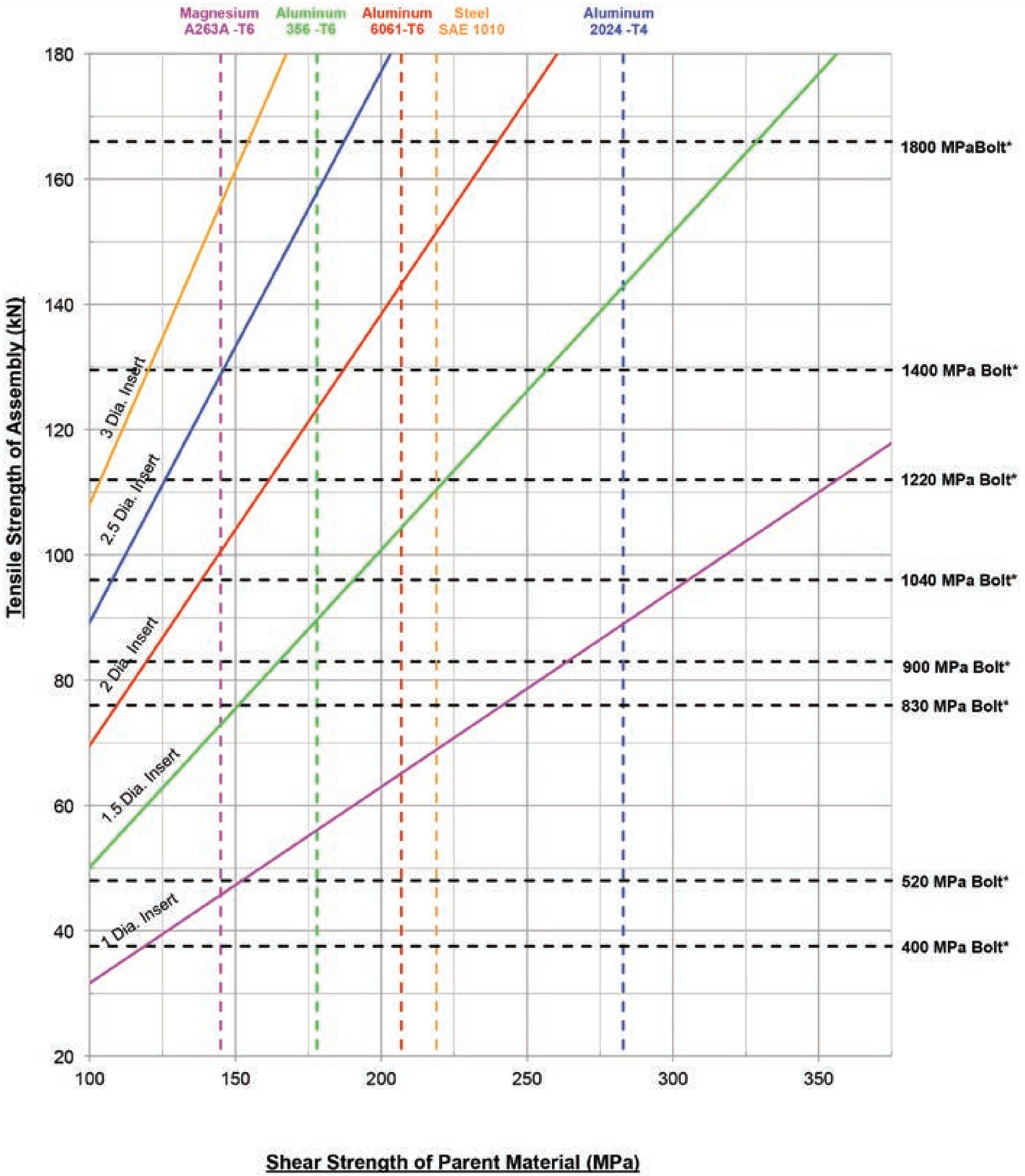
Tensile Strength of Heli-Coil Assembly vs. Shear Strength of Parent Material for M10x1.5 Size

(*) Bolt Material Ultimate Tensile Strength



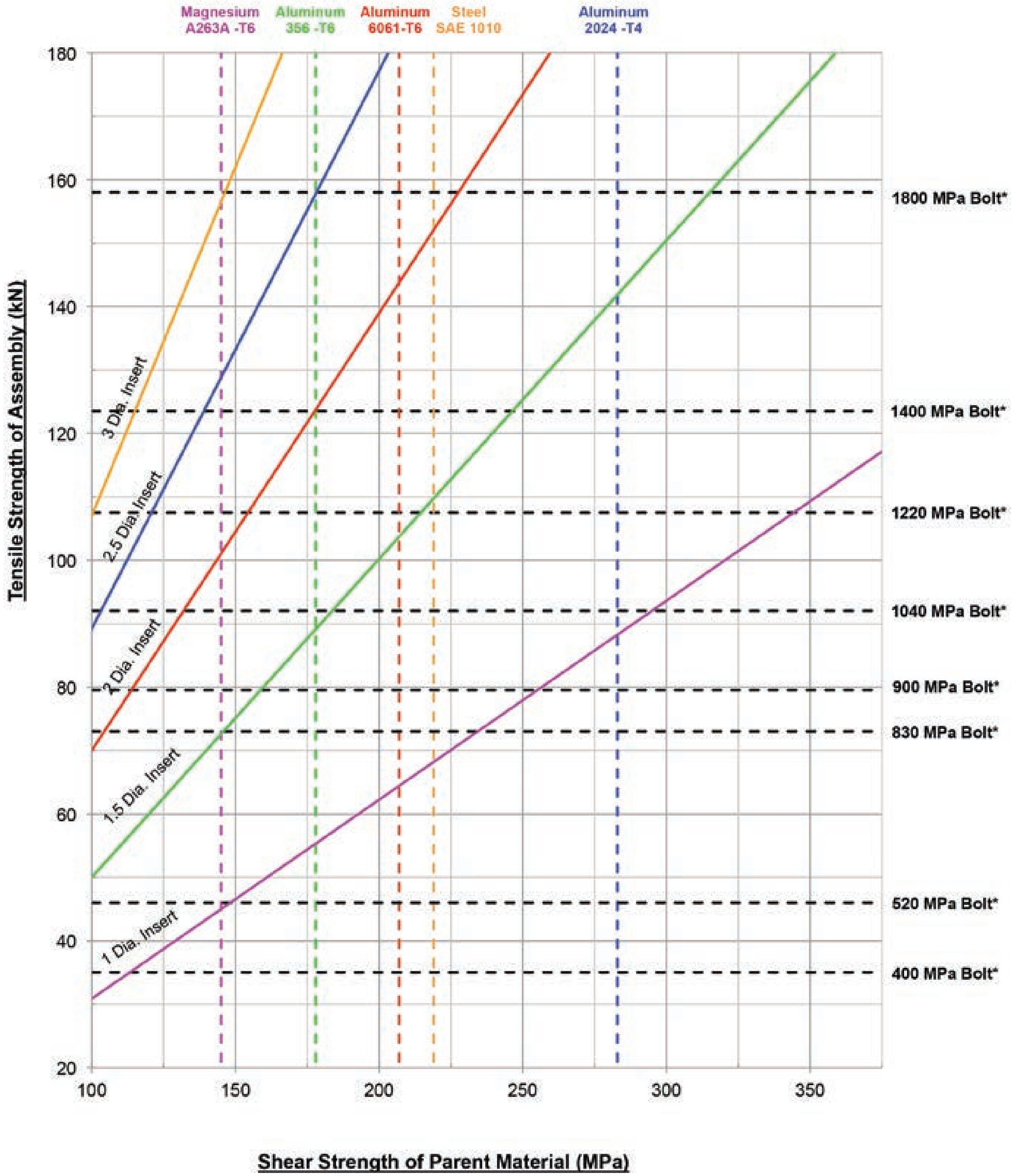
Tensile Strength of Heli-Coil Assembly vs. Shear Strength of Parent Material for M12x1.25 Size

(*) Bolt Material Ultimate Tensile Strength



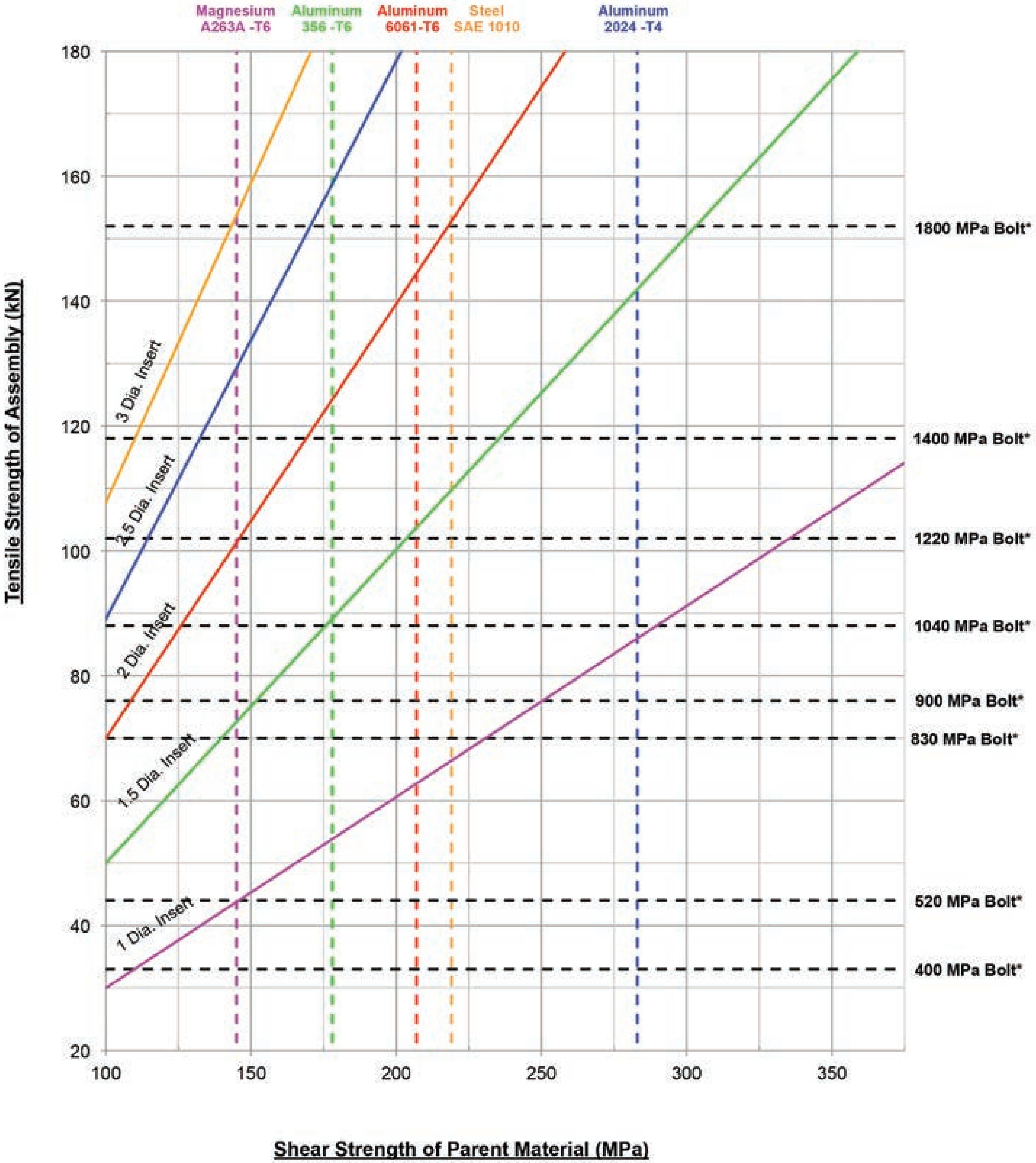
Tensile Strength of Heli-Coil Assembly vs. Shear Strength of Parent Material for M12x1.5 Size

(*) Bolt Material Ultimate Tensile Strength



Tensile Strength of Heli-Coil Assembly vs. Shear Strength of Parent Material for M12x1.75 Size

(*) Bolt Material Ultimate Tensile Strength



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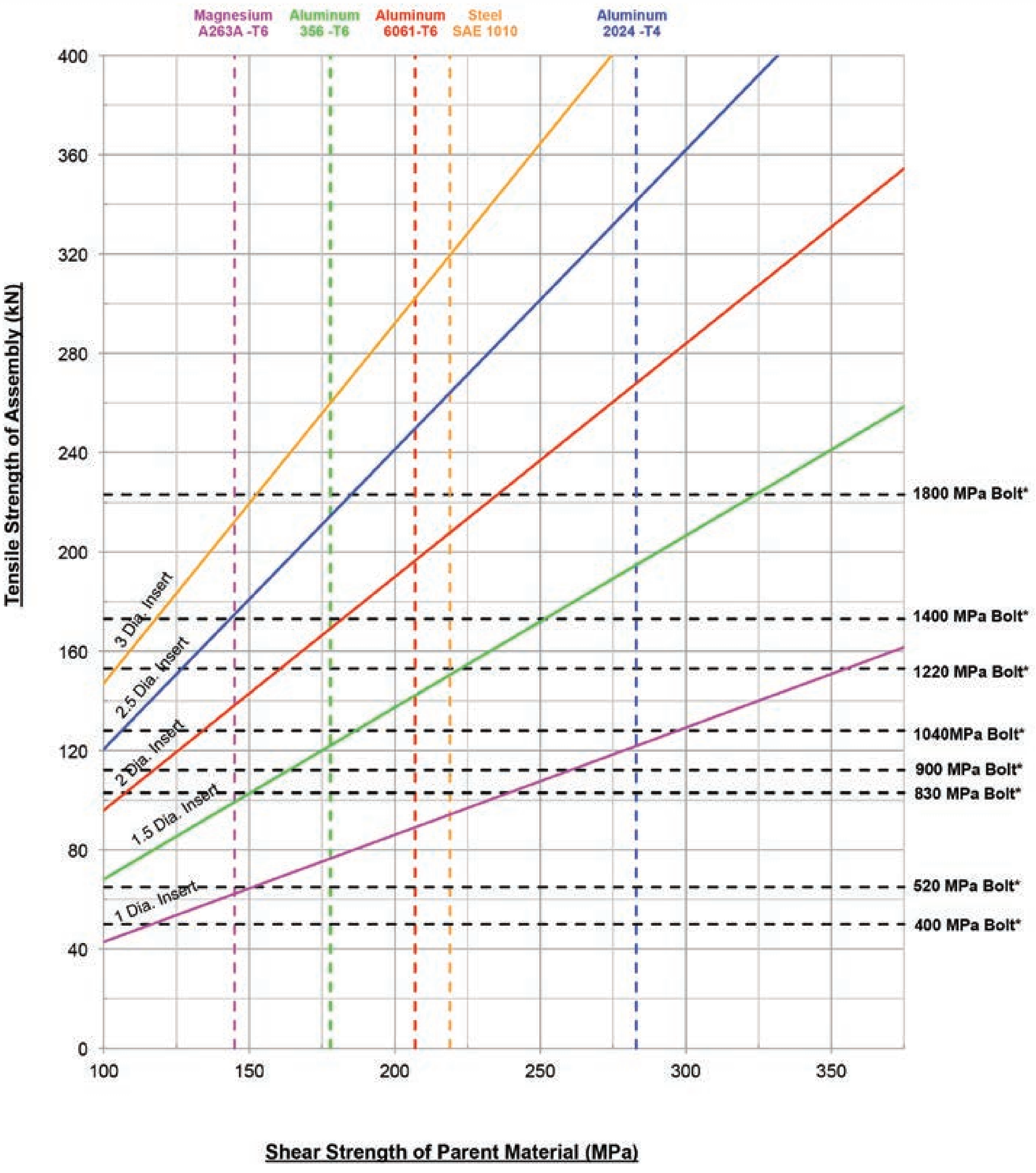
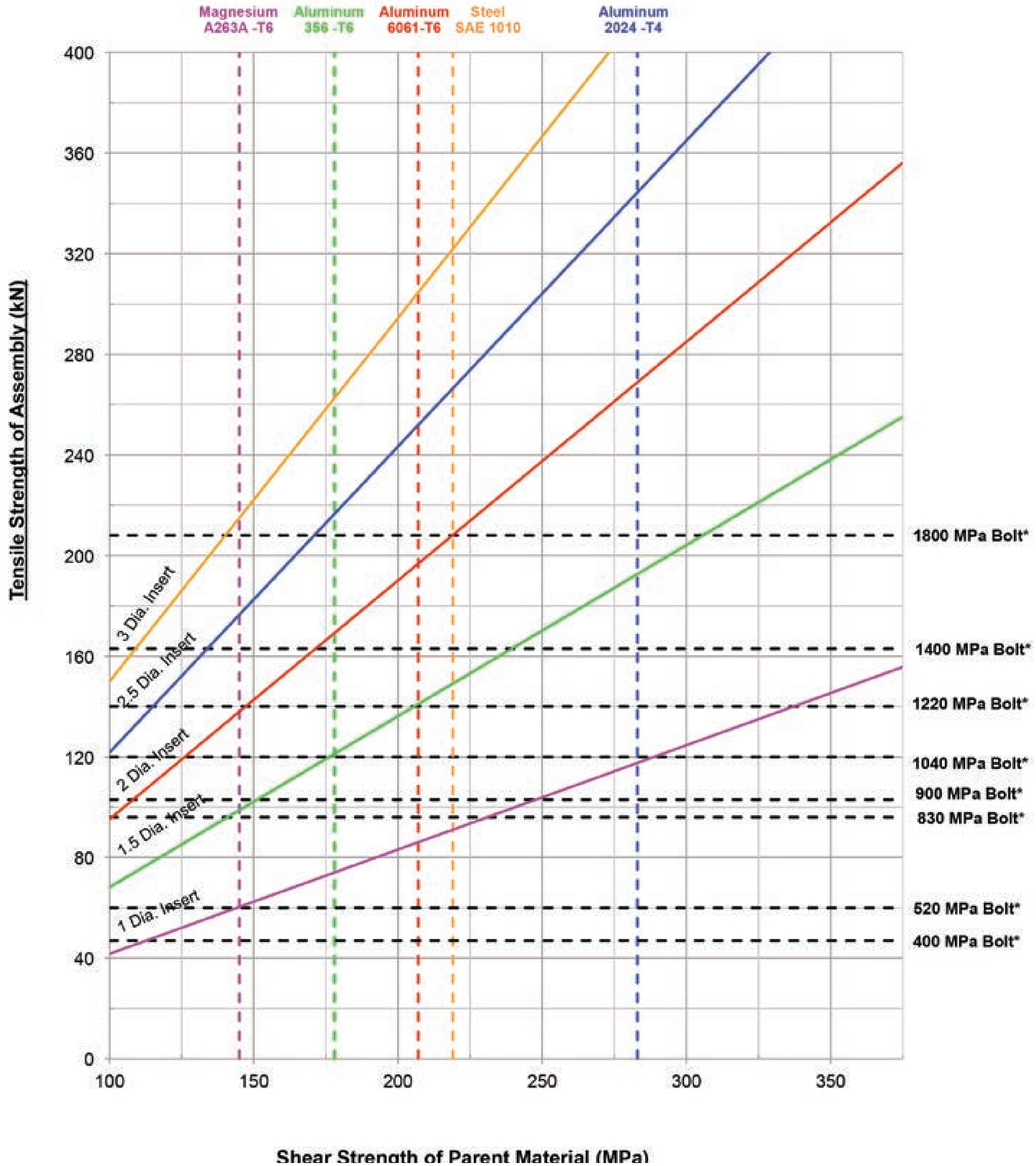
Tensile Strength of Heli-Coil Assembly vs. Shear Strength of Parent Material for M14x1.5 Size

(*) Bolt Material Ultimate Tensile Strength



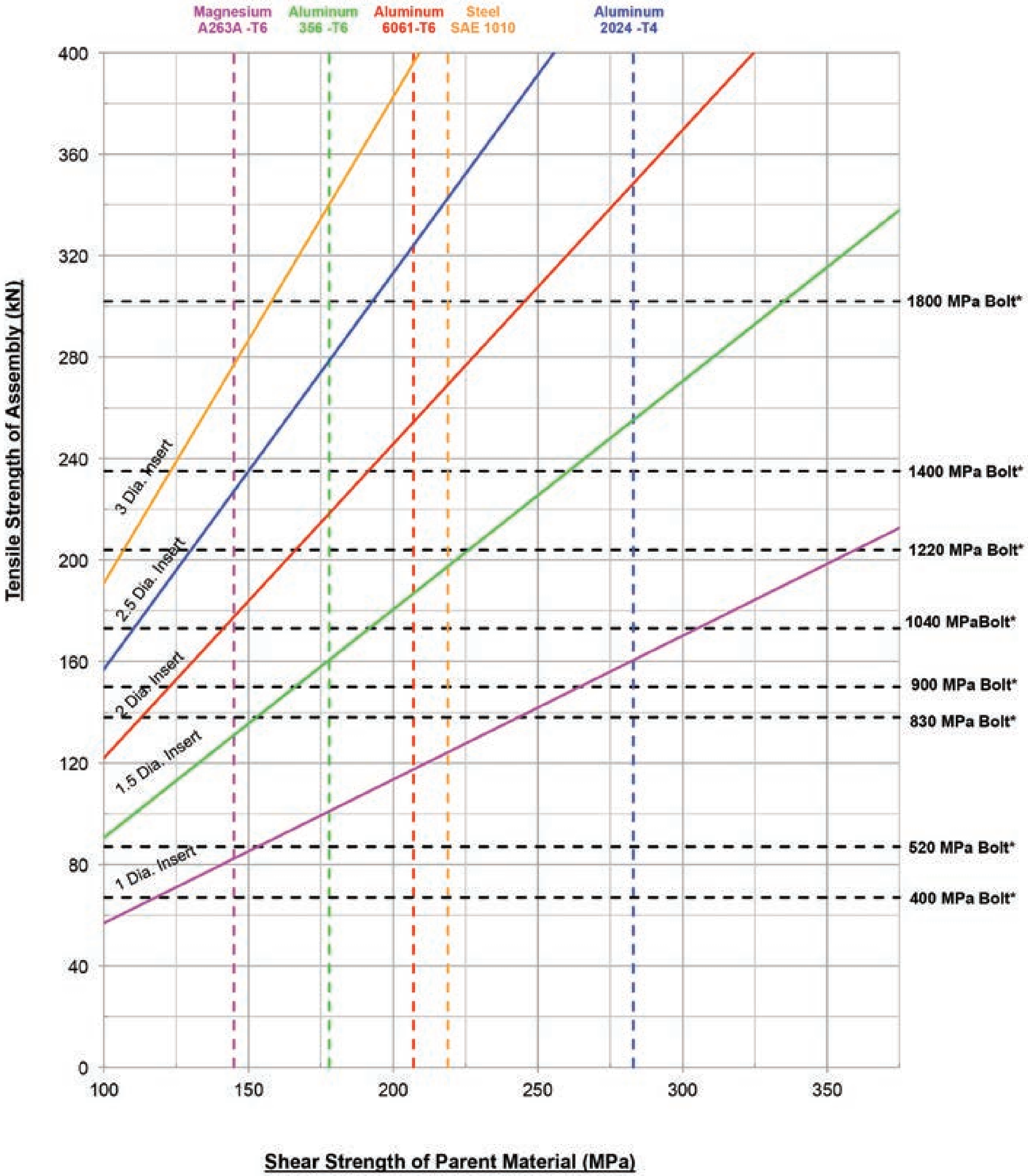
Tensile Strength of Heli-Coil Assembly vs. Shear Strength of Parent Material for M14x2 Size

(*) Bolt Material Ultimate Tensile Strength



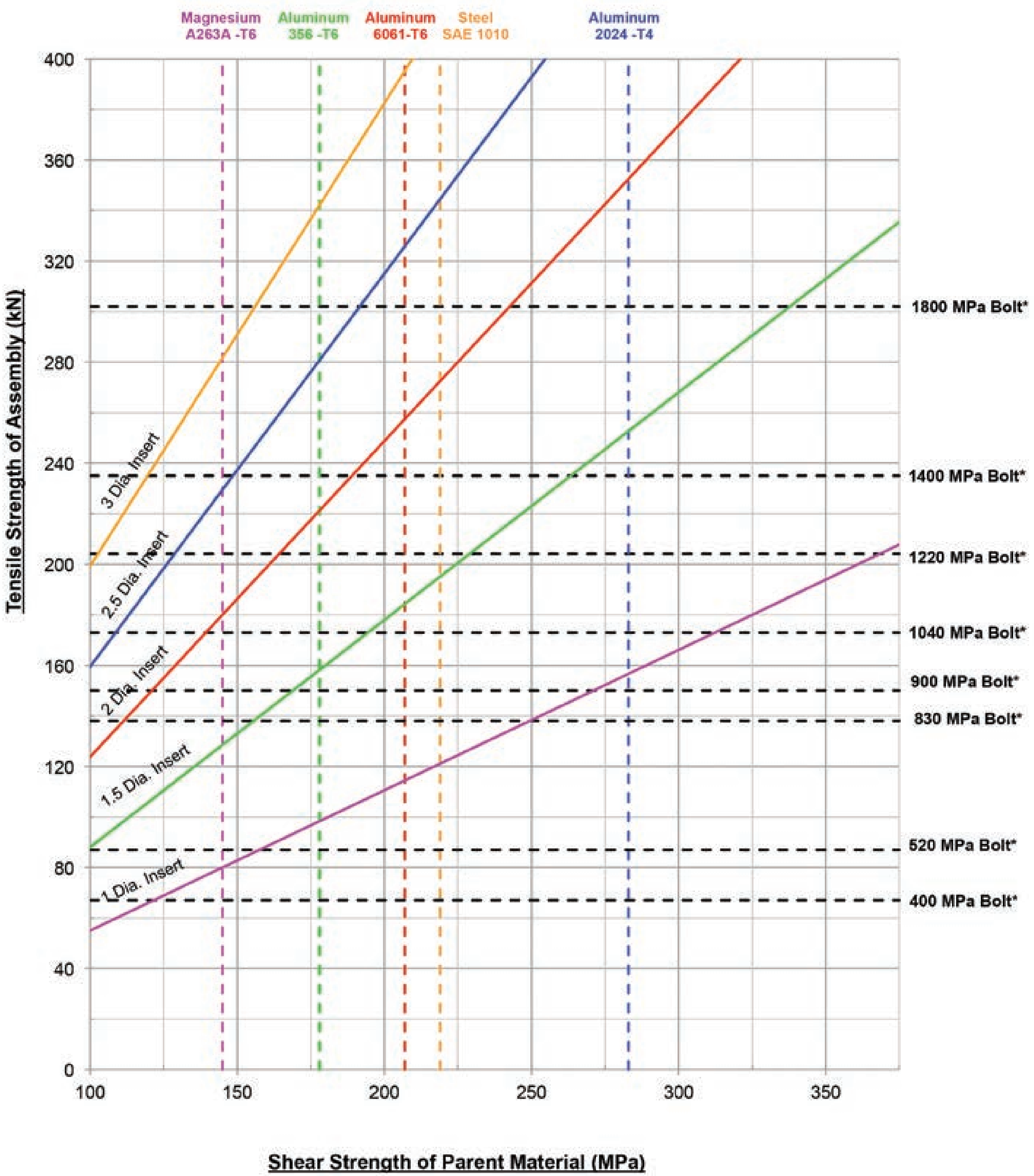
Tensile Strength of Heli-Coil Assembly vs. Shear Strength of Parent Material for M16x1.5 Size

(*) Bolt Material Ultimate Tensile Strength



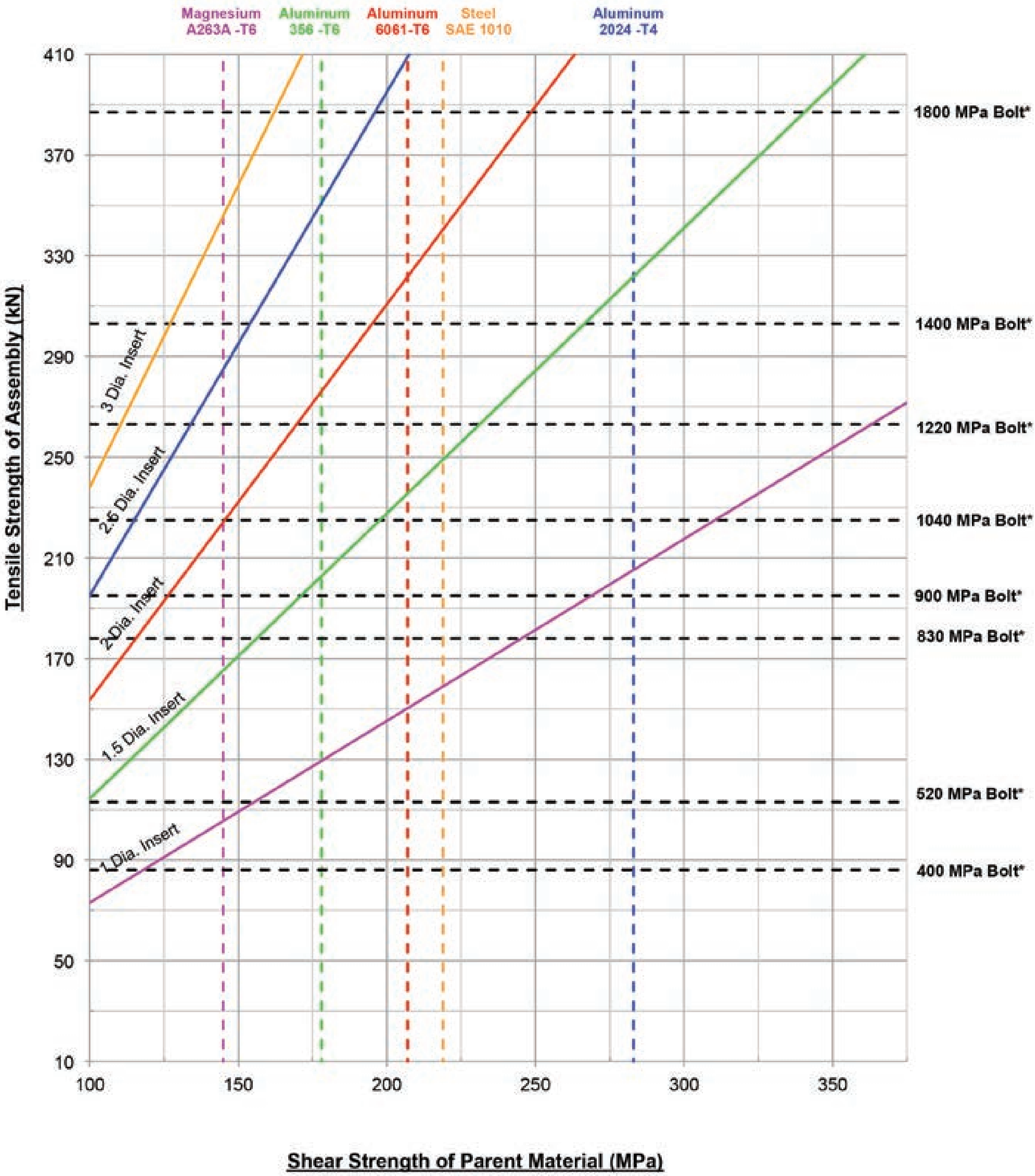
Tensile Strength of Heli-Coil Assembly vs. Shear Strength of Parent Material for M16x2 Size

(*) Bolt Material Ultimate Tensile Strength



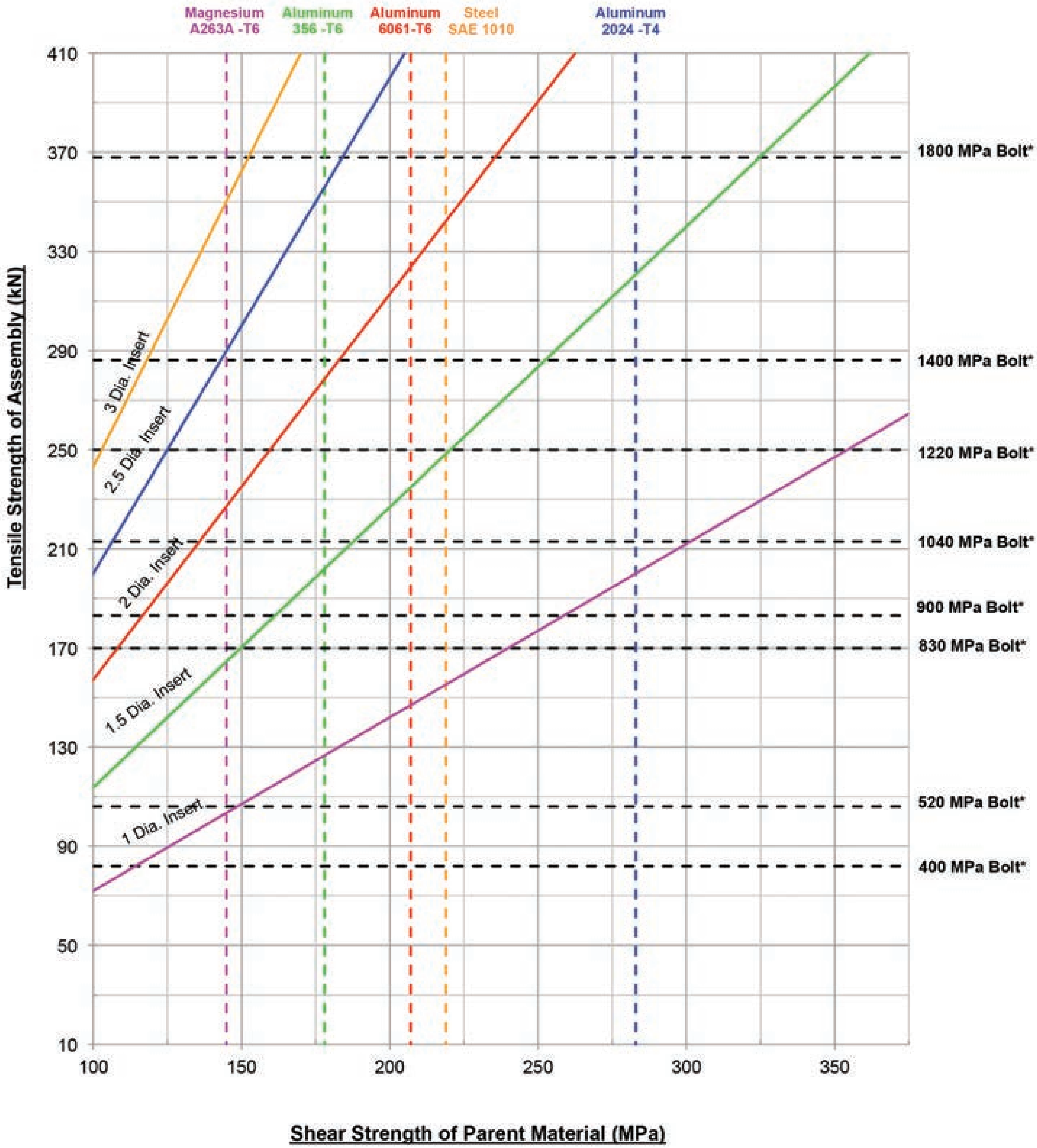
Tensile Strength of Heli-Coil Assembly vs. Shear Strength of Parent Material for M18x1.5 Size

(*) Bolt Material Ultimate Tensile Strength



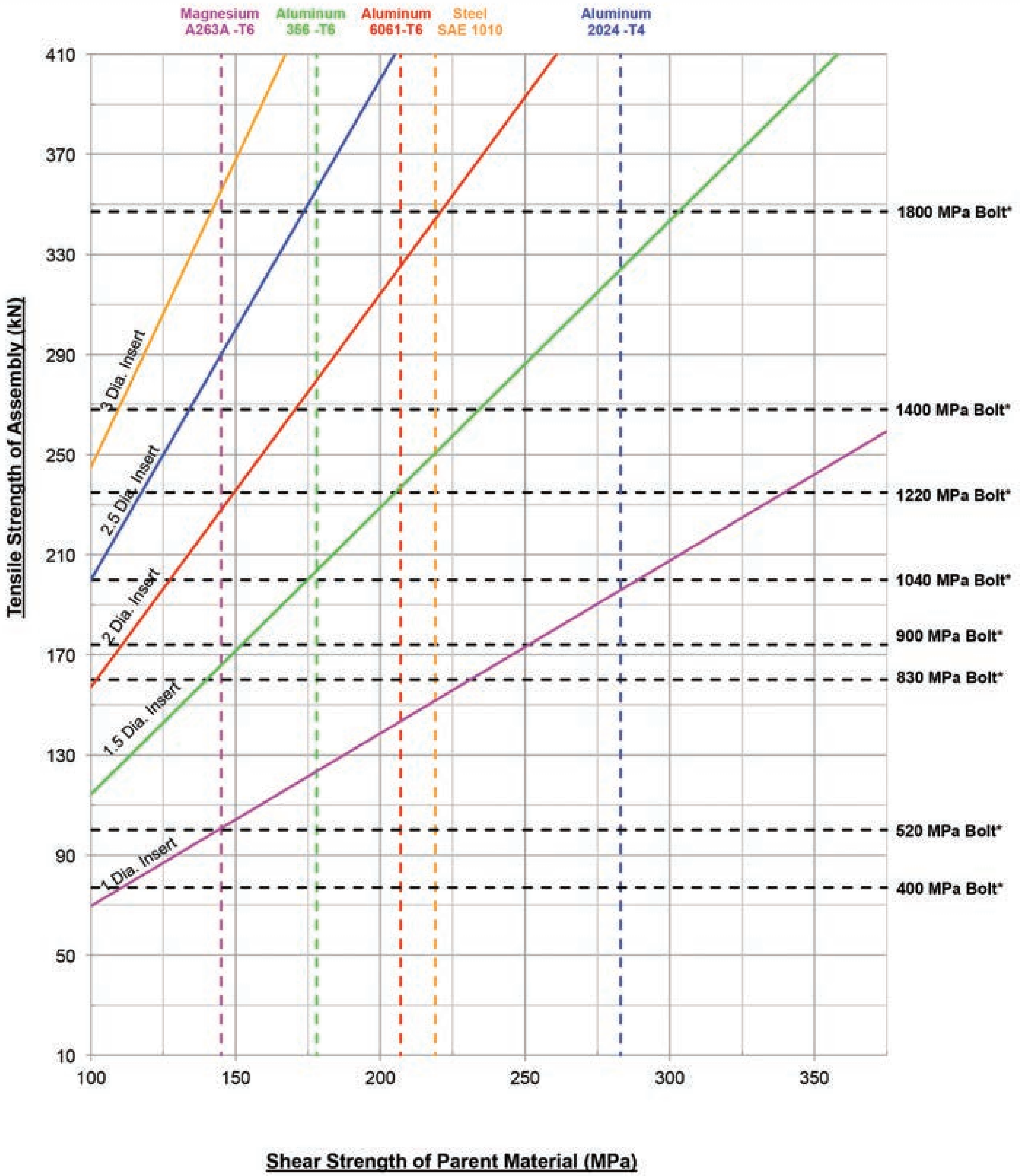
Tensile Strength of Heli-Coil Assembly vs. Shear Strength of Parent Material for M18x2 Size

(*) Bolt Material Ultimate Tensile Strength



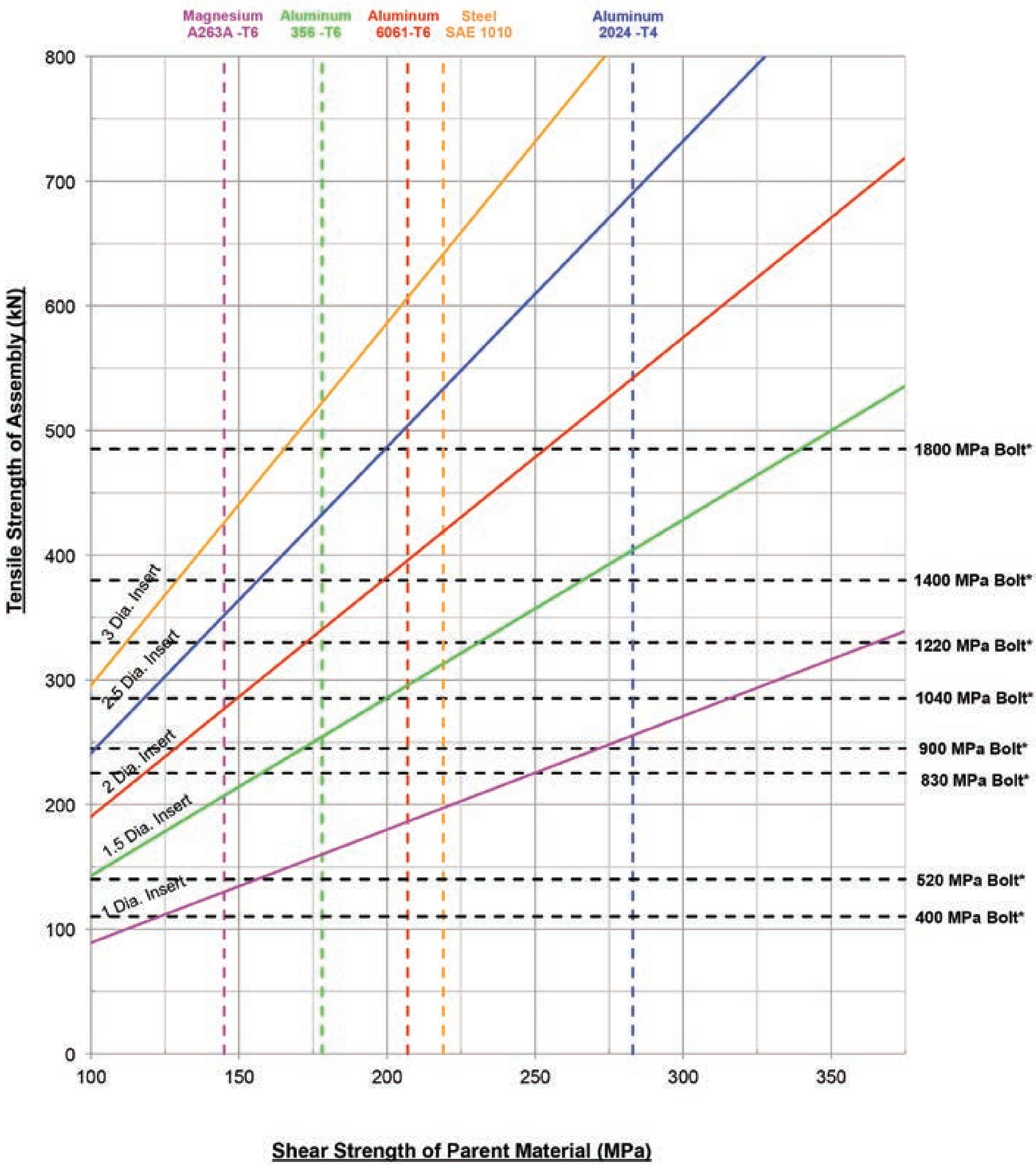
Tensile Strength of Heli-Coil Assembly vs. Shear Strength of Parent Material for M18x2.5 Size

(*) Bolt Material Ultimate Tensile Strength



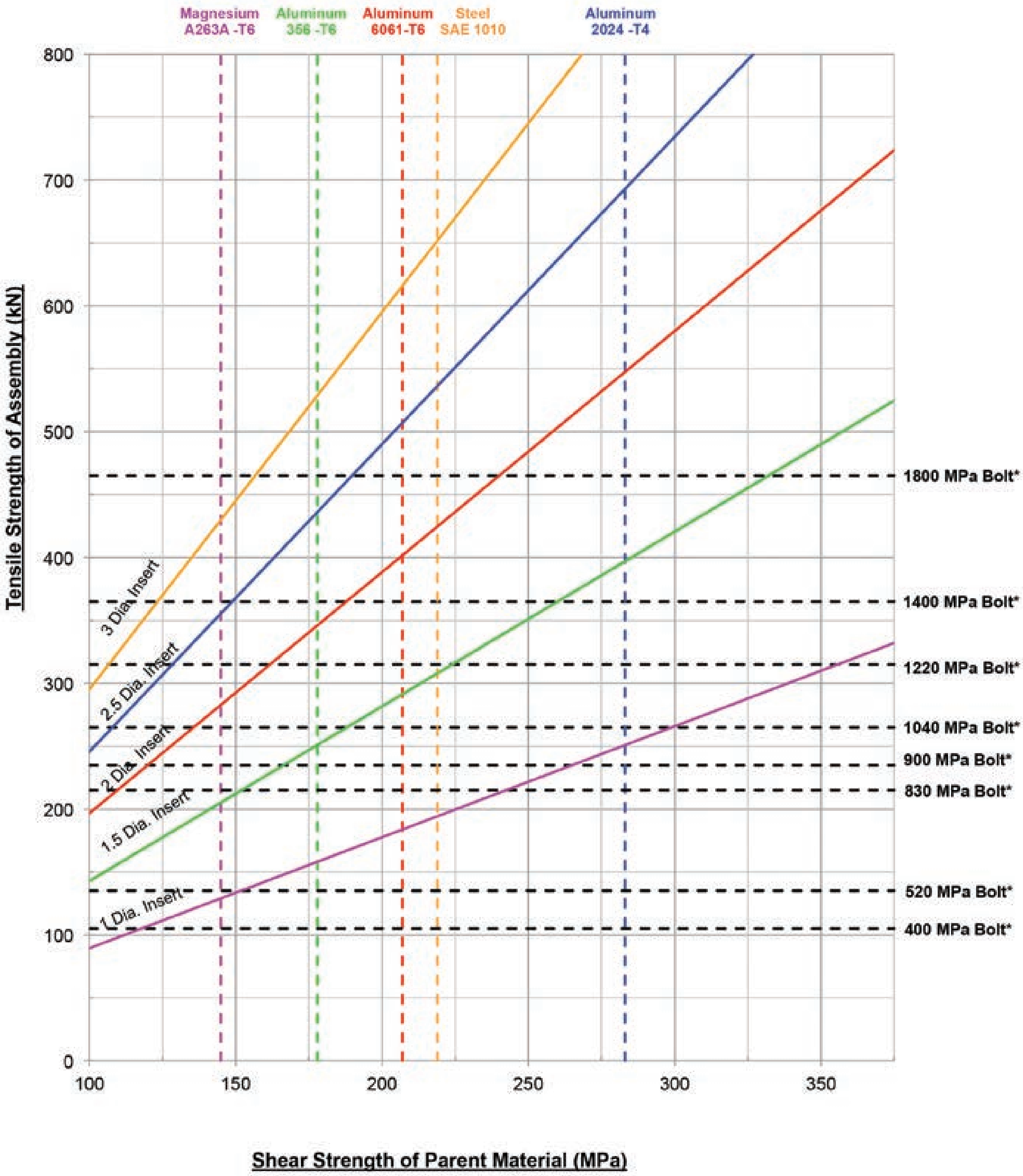
Tensile Strength of Heli-Coil Assembly vs. Shear Strength of Parent Material for M20x1.5 Size

(*) Bolt Material Ultimate Tensile Strength



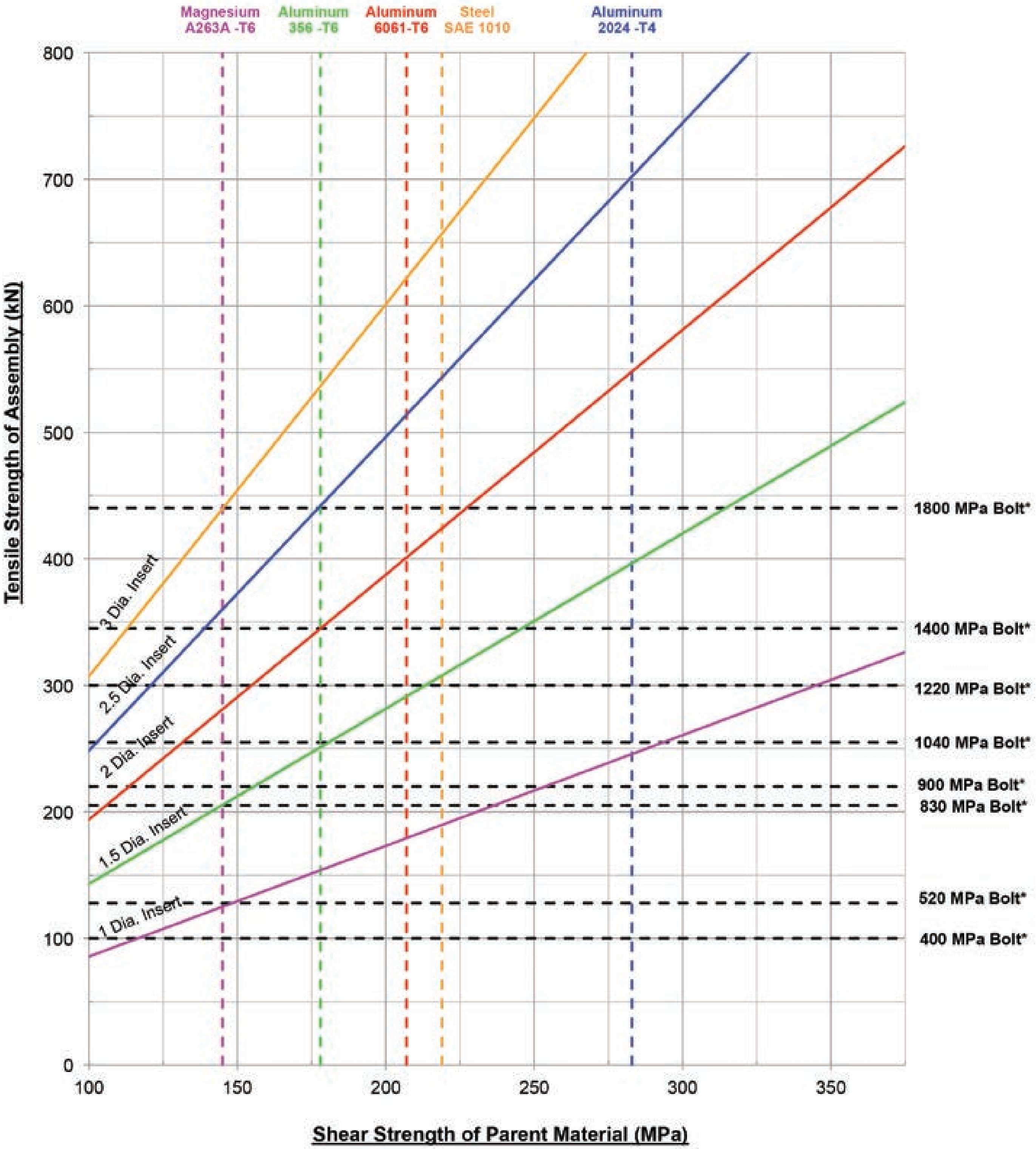
Tensile Strength of Heli-Coil Assembly vs. Shear Strength of Parent Material for M20x2 Size

(*) Bolt Material Ultimate Tensile Strength



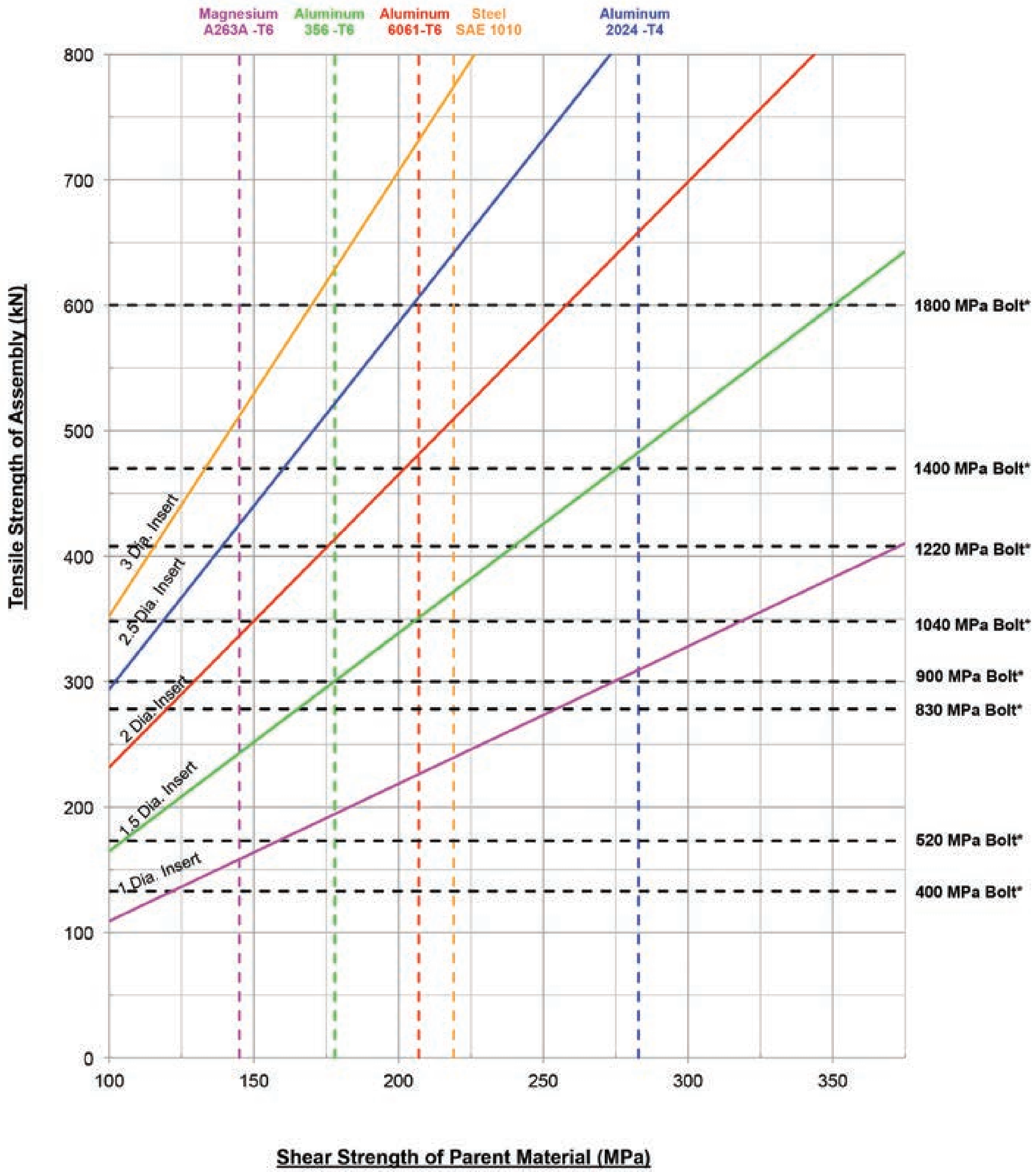
Tensile Strength of Heli-Coil Assembly vs. Shear Strength of Parent Material for M20x2.5 Size

(*) Bolt Material Ultimate Tensile Strength



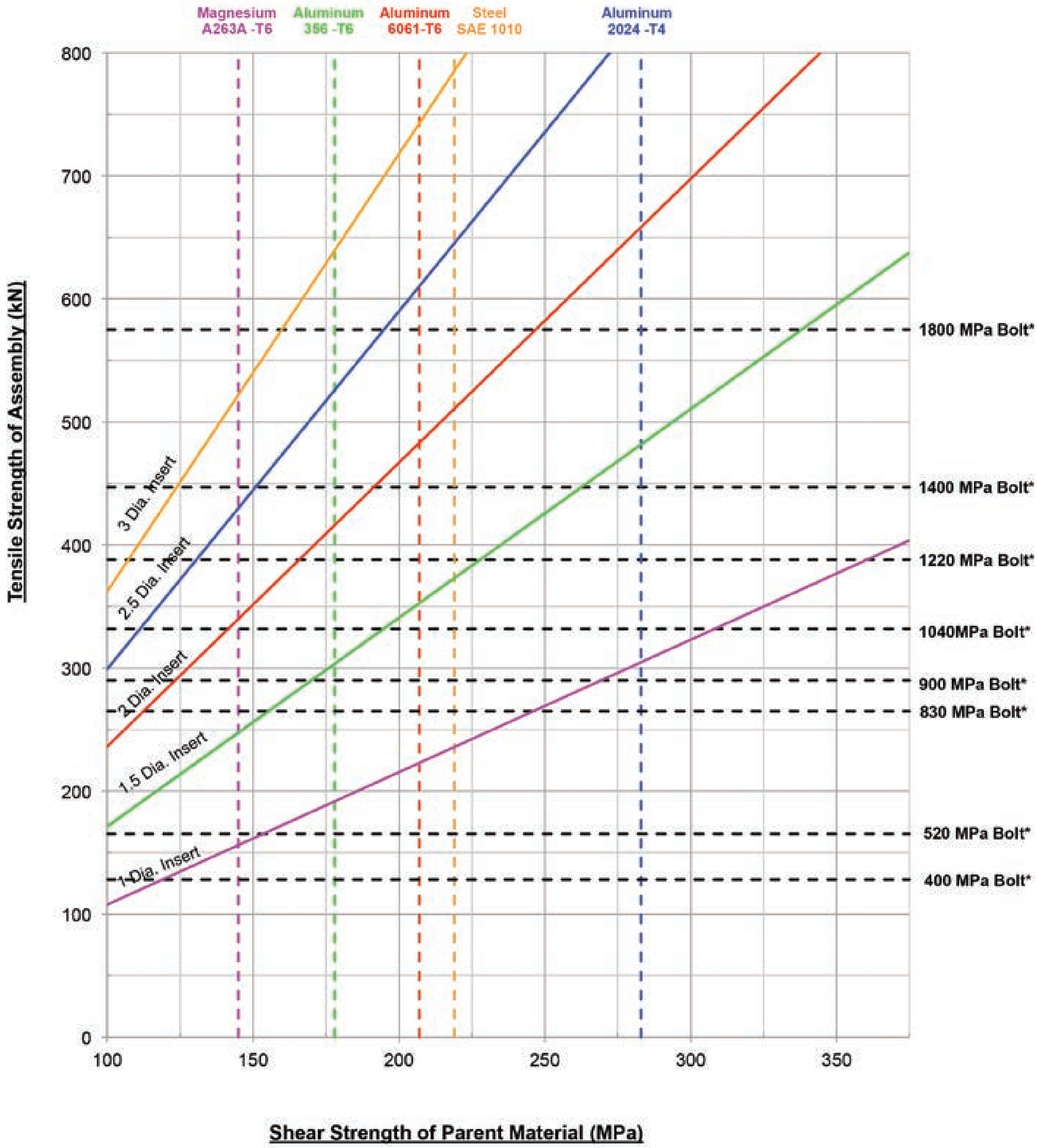
Tensile Strength of Heli-Coil Assembly vs. Shear Strength of Parent Material for M22x1.5 Size

(*) Bolt Material Ultimate Tensile Strength



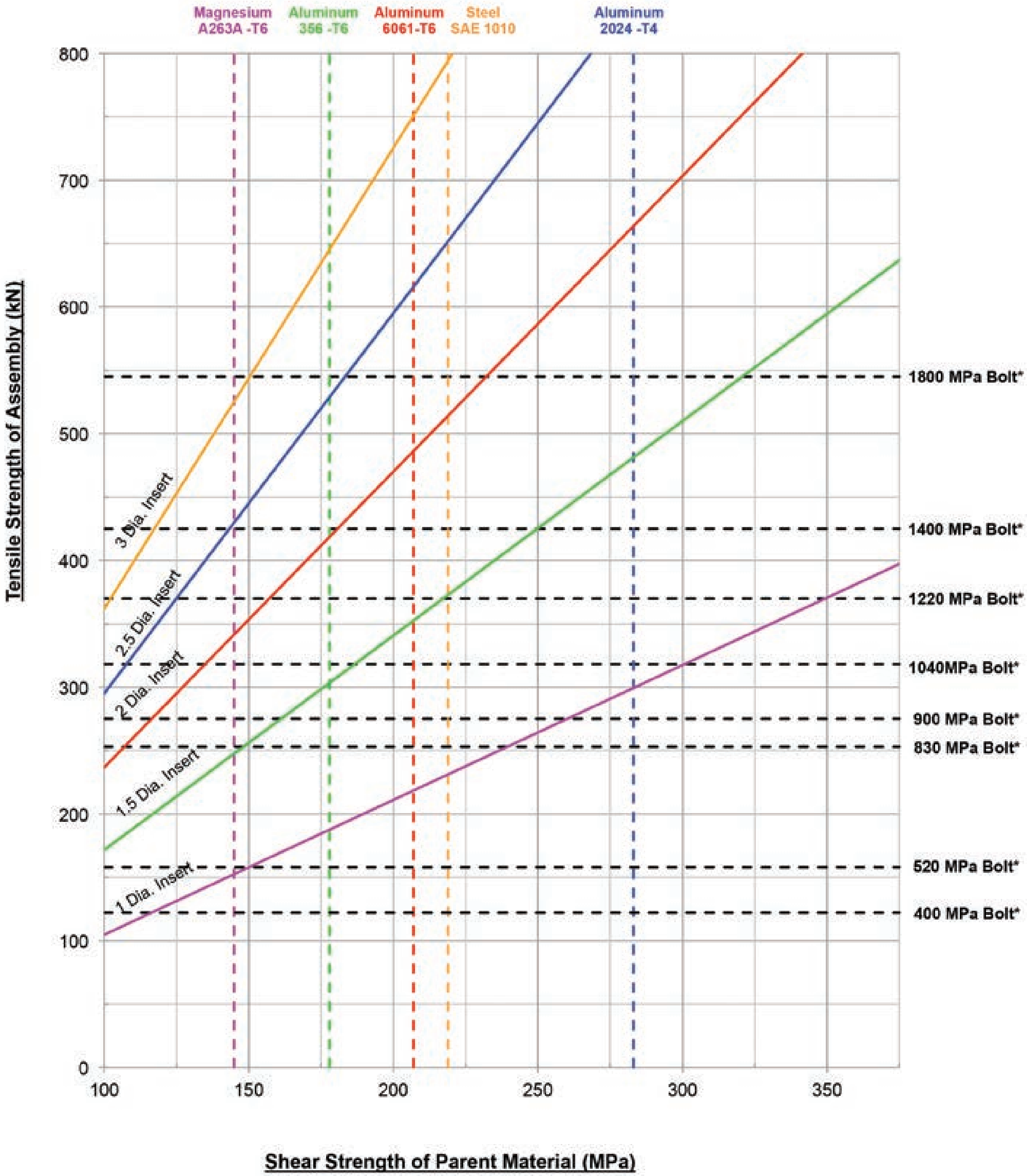
Tensile Strength of Heli-Coil Assembly vs. Shear Strength of Parent Material for M22x2 Size

(*) Bolt Material Ultimate Tensile Strength



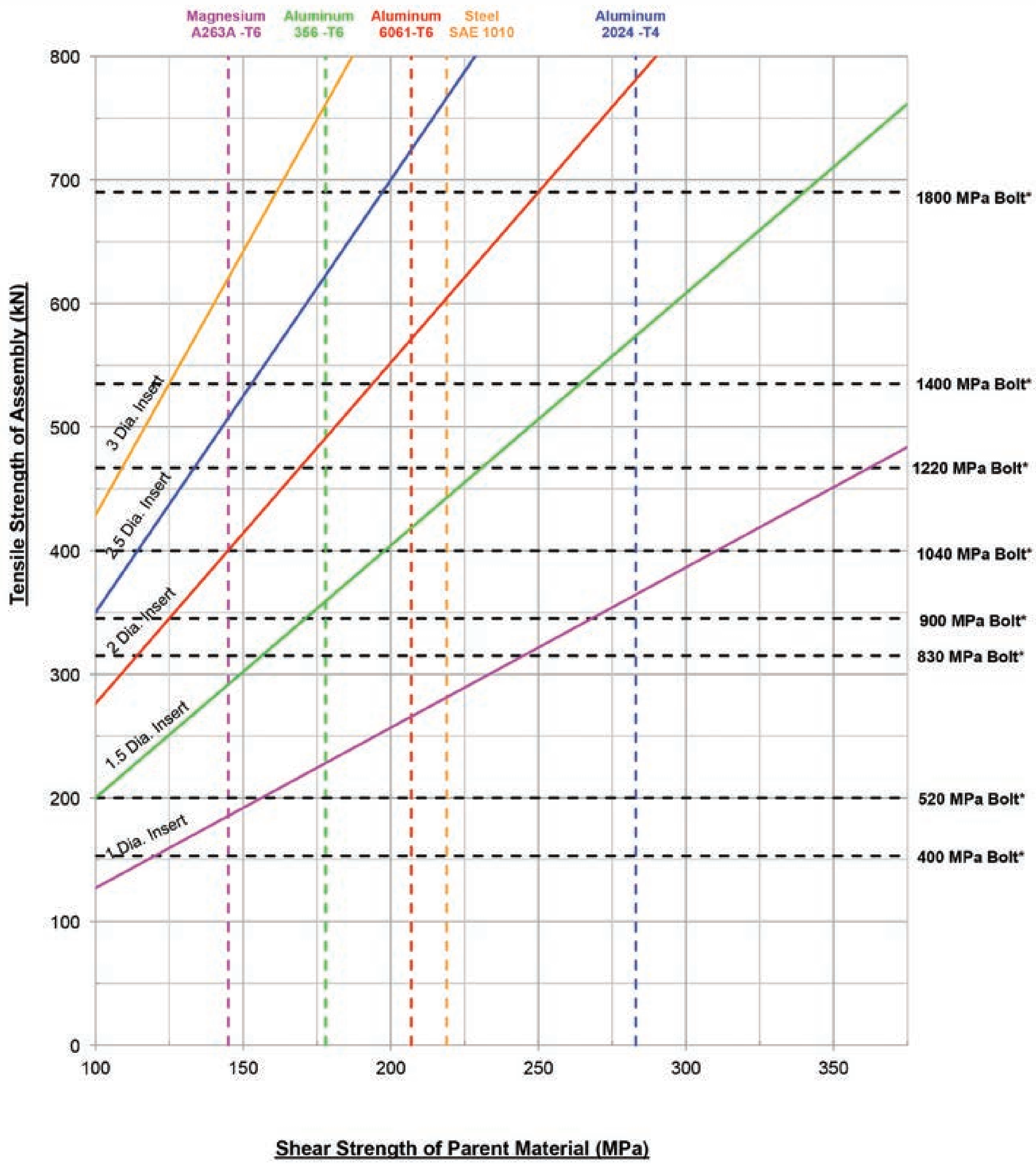
Tensile Strength of Heli-Coil Assembly vs. Shear Strength of Parent Material for M22x2.5 Size

(*) Bolt Material Ultimate Tensile Strength



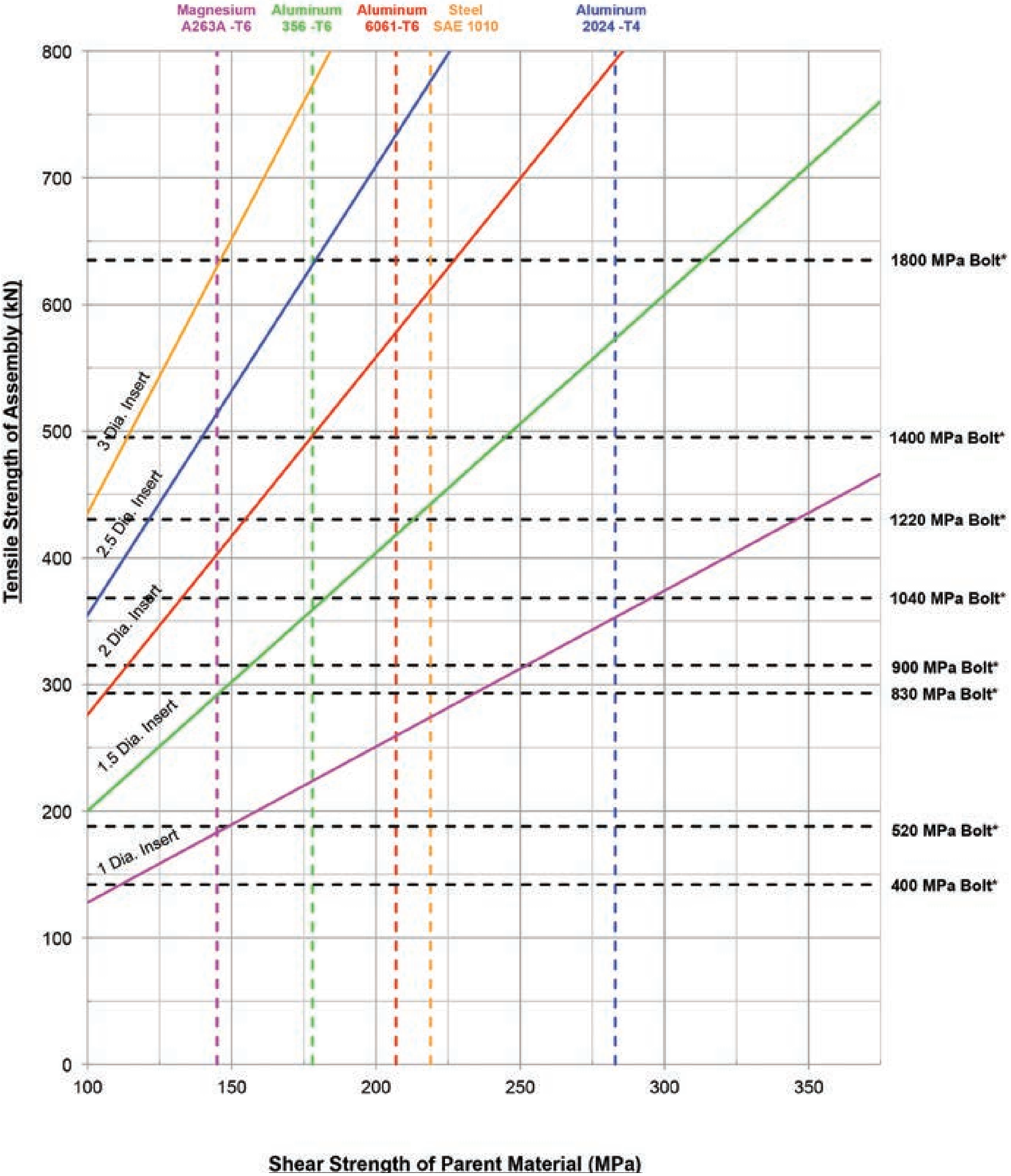
Tensile Strength of Heli-Coil Assembly vs. Shear Strength of Parent Material for M24x2 Size

(*) Bolt Material Ultimate Tensile Strength



Tensile Strength of Heli-Coil Assembly vs. Shear Strength of Parent Material for M24x3 Size

(*) Bolt Material Ultimate Tensile Strength



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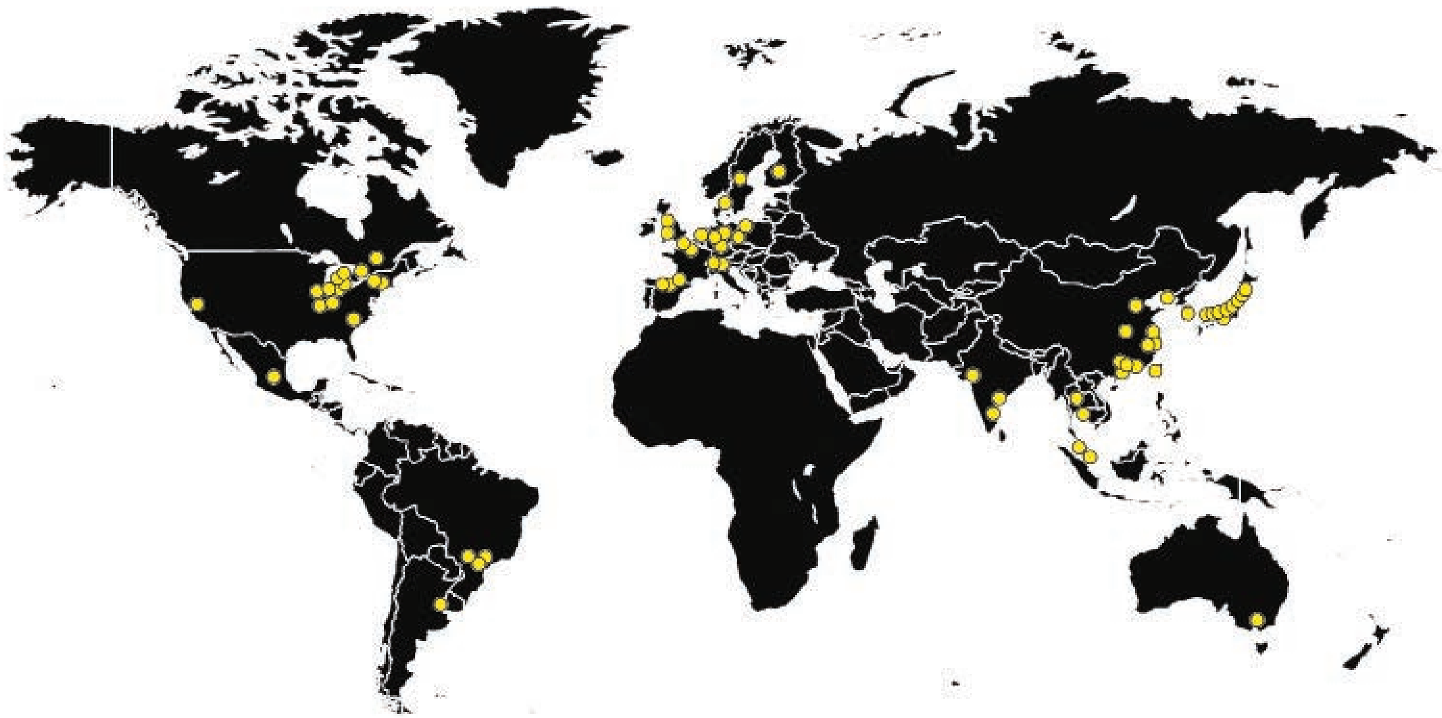

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