COLUMN LOADING

When a ballscrew shaft is subjected to an axially compressive load, the ability to resist buckling must be ascertained.

Figure 9. provides the values of the maximum safe load a ballscrew will sustain for various unsupported lengths and different types of bearing support. The upper horizontal portion of each line shows the maximum working compressive load the screw will carry. This value is also the maximum working tensile load. For other than optimum conditions an appropriate additional safety factor should be allowed.

Note: The maximum static load limitation, beyond which brinelling of the balltrack in the screw and nut will occur must not be exceeded. this value is given in the Ballscrew Data Sheets.

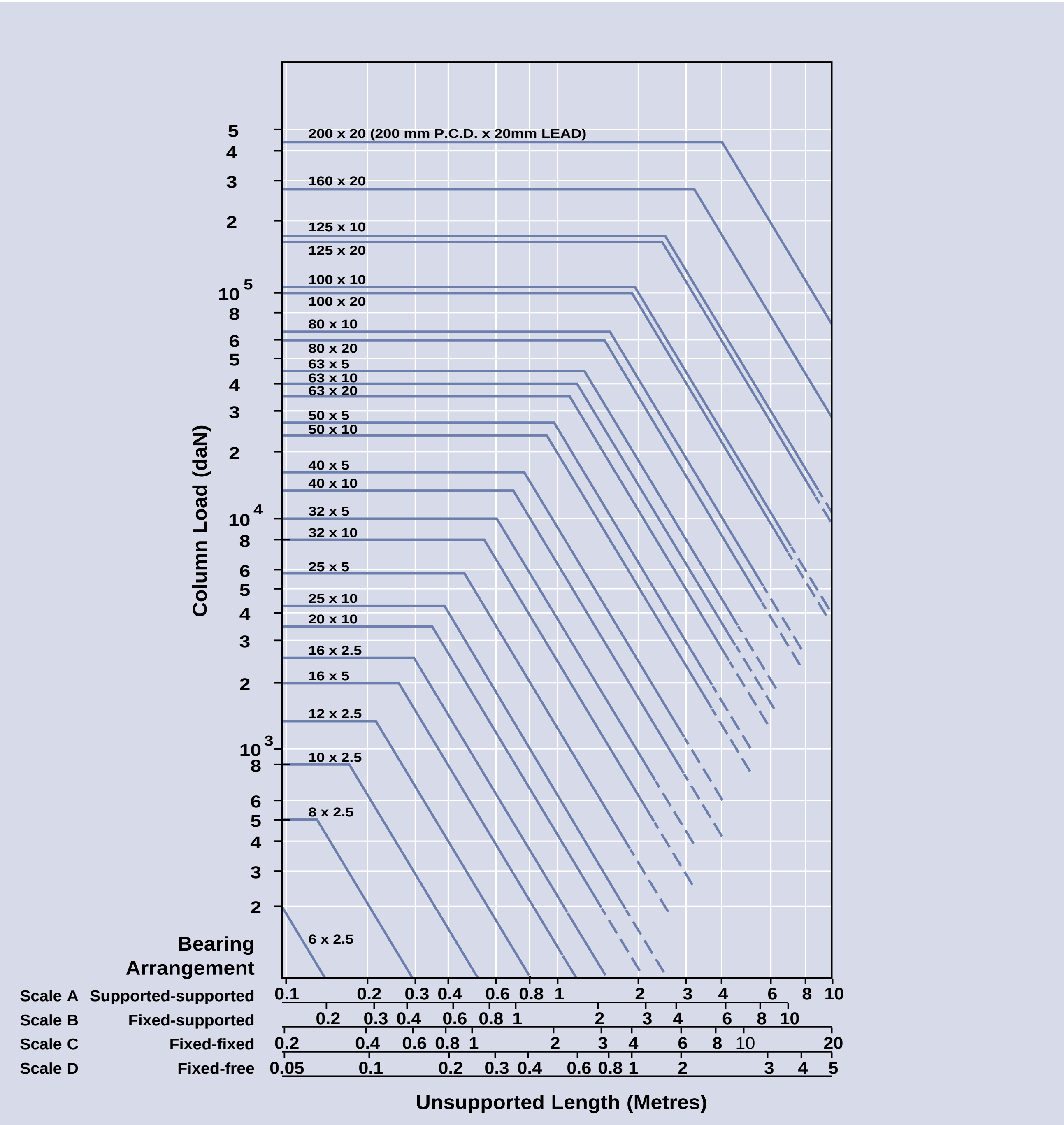

Fig. 9

SHAFT AXIAL RIGIDITY

The rigidity of the ballscrew shaft depends upon the bearing arrangement. For one end fixed and the other end either free, or simply supported (see fig. 10)

$$Rs = \frac{A \cdot E}{1000 \cdot a} \quad \text{which} = \frac{210 \cdot A}{a} \quad \text{when } E = 210000 \text{ N/mm}^2$$

For both ends fixed (see Fig. 10)

$$Rs = \frac{A \cdot E \cdot L}{1000 \cdot a \cdot (L-a)}$$

$$\text{which} = \frac{210 \cdot A \cdot L}{a \cdot (L-a)} \quad \text{when } E = 210000 \text{ N/mm}^2$$

For Fig. 10 condition, the minimum rigidity occurs when the nut is in the mid-position of the ballscrew shaft between bearings. At this point:

$$\text{Minimum } Rs = \frac{4 \cdot A \cdot E}{1000 \cdot L}$$

$$\text{which} = \frac{840 \cdot A}{L} \quad \text{when } E = 210000 \text{ N/mm}^2$$

where

Rs = rigidity of ballscrew shaft (N/µm)

A = $\pi/4$ x (average screw diam)^2 (mm^2)

L = unsupported length of screw shaft (mm)

E = Young's modulus (N/mm^2)

a,L = lengths (mm)

SHAFT TORSIONAL RIGIDITY

The applied torque will twist a shaft and, in the case of a long ballscrew of small diameter, this torsional deflection may cause positional errors.

The angular deflection produced by a torque is given by the following formula:

$$\alpha = \frac{584 \cdot T \cdot L}{(d_2^4) \cdot G}$$

and for G = 80000N/mm^2 this becomes:

$$\alpha = \frac{0.0073 \cdot T \cdot L}{(d_2^4)}$$

where

α = angular deflection (degrees)

T = applied torque (Nmm)

L = length of shaft subjected to torque (mm)

d_2 = root diameter of the ballscrew (mm)

G = torsional modulus of elasticity (N/mm^2)

In NC machines an allowance should be made for twisting, if significant, which may be seen as an axial positioning error, the value of which is given by:

$$\tilde{o} = \pm \frac{\alpha \cdot P}{360°}$$

where

õ = apparent axial displacement (mm)

P = lead (mm)

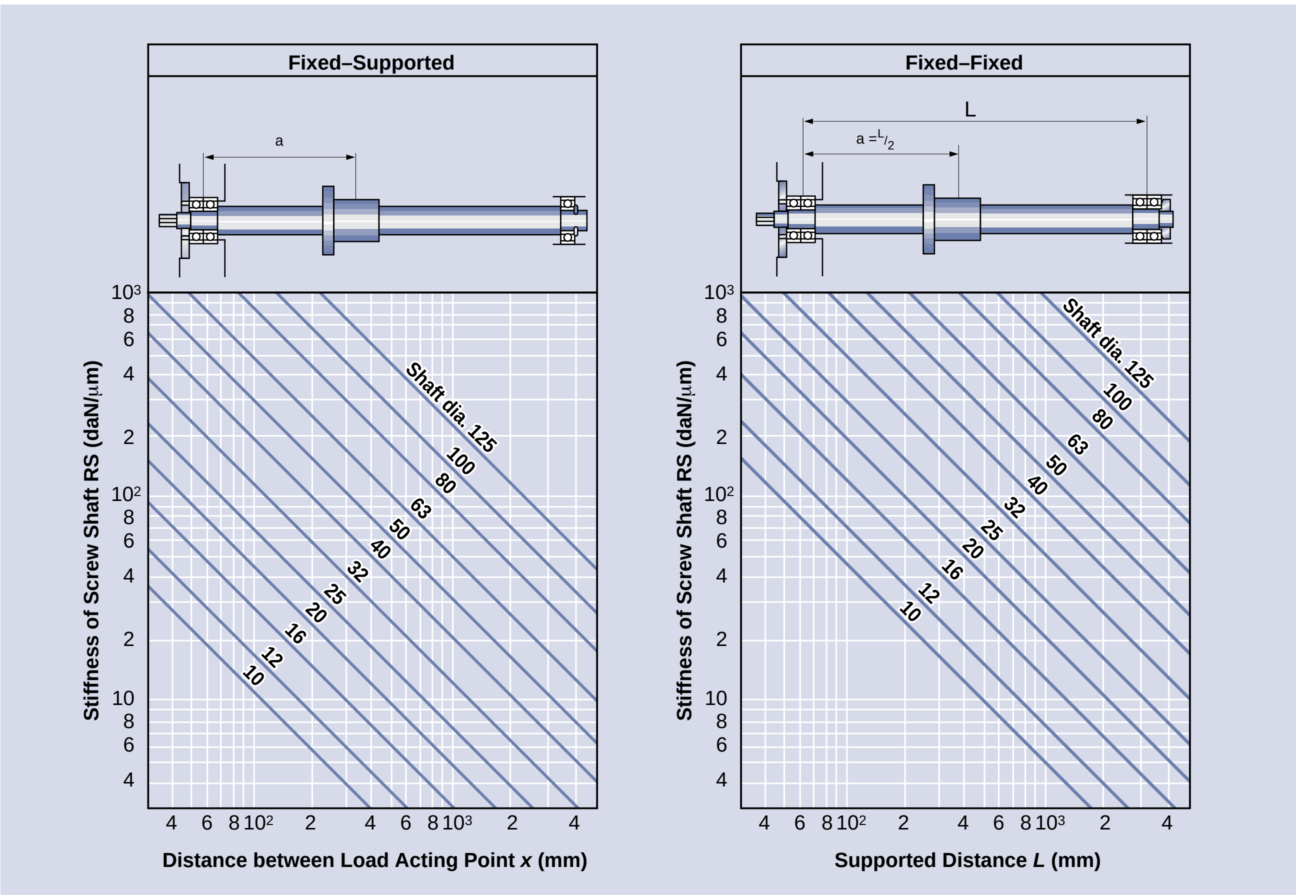

FIG. 10