**Example of Selection of Ball Screws** (For X-Axis of Orthogonal Robot)

1. Setting Lead(L)

Set lead based on maximum revolution and threading speed. Use the following formula.

\[ L = \frac{\pi}{4} \times 10^{3} \times \text{Axial Load(Pc)} \text{ (kgf)} \]

2. Calculating Basic Dynamic Load Rating

Examine the required basic dynamic load rating and the allowable revolution frequency as follows.

\[ L_{\text{req}} = \frac{4 \times 10^{5} \times (\pi/4) \times 10^{3} \times \text{Axial Load(Pc)} \text{ (kgf)}}{7200 \times 60 \times \text{Operating Time (hrs)}} \]

3. Allowable Bearing Load - Critical Speed

Investigating of full-length of thread lead(Lc), critical speed(Nc), and bearing load(Pb) can be calculated as per the following formula.

\[ Lc = \frac{10^{3} \times \pi}{4} \times \text{Axial Load(Pc)} \text{ (kgf)} \]

\[ Nc = \frac{10^{5}}{4 \times 10^{3}} \times \text{Axial Load(Pc)} \text{ (kgf)} \]

4. Design Precision

Investigating of Precision Class and Axial Play

According to the tolerance values for lead accuracy(0.005), the class of positioning precision is set at 0.178/cm. Accumulative total lead error is 0.033 (0.025% accuracy).

5. Results of the Selection of Ball Screws and Support Units

From the previous calculation, the load of the ball screw is 14927(N).

6. Reference Formulas

\[ \text{Driving Torque} = \frac{1}{2} \pi \times 10^{3} \times \text{Critical Speed} \times \text{Axial Load(Pc)} \text{ (kgf)} \]

**Friction and Efficiency**

Ball screw efficiency can be expressed as follows:

\[ \text{Efficiency} = \frac{1}{2} \times \text{Ball Screw Efficiency} \]

Operating Pattern: (A) At Constant Speed

Operating Pattern: (B) In Acceleration

**Buckling Load(Pc)**

\[ \text{Buckling Load} = \frac{\pi}{4} \times 10^{3} \times \text{Axial Load(Pc)} \text{ (kgf)} \]

Operating Hours Per Cycle for Each Operating Pattern

**Tape & Cylinder Diagram**

- **Work & Tape Mass**
- **Maximum Driving Speed**
- **Threaded Speed**
- **Acceleration Coefficient**
- **Positioning Precision**
- **Threaded Accuracy**
- **Direct Axle Guide Position of Feed**
- **Driving Motor**
- **Cycle Motor Diagram**

**Reference Formulas**

\[ \text{Driving Torque} = \frac{1}{2} \pi \times 10^{3} \times \text{Critical Speed} \times \text{Axial Load(Pc)} \text{ (kgf)} \]

\[ \text{Buckling Load}(Pc) = \frac{\pi}{4} \times 10^{3} \times \text{Axial Load(Pc)} \text{ (kgf)} \]

**Buckling Load(Pc)**

\[ \text{Buckling Load} = \frac{\pi}{4} \times 10^{3} \times \text{Axial Load(Pc)} \text{ (kgf)} \]

Driving Torque

\[ \text{Driving Torque} = \frac{1}{2} \pi \times 10^{3} \times \text{Critical Speed} \times \text{Axial Load(Pc)} \text{ (kgf)} \]

**Friction Torque Caused by Preloading**

This is a torque generated by preloading. As external loads increase, the preload of the nut is released and therefore the friction torque by preloading also decreases.