

Life

Ball screw life is determined by the nomogram (see next page) or calculated as follows:

$$L = \frac{C}{Q}^3 \cdot 10^6$$

C static carrying capacity, kN;

Q equivalent dynamic load, kN.

Ball screw equivalent dynamic load Q is greatest value of two equivalent loads Q₁ and Q₂ for each nut.

Axial forces Q_{i1} (i=1, 2, ... k) from the first nut side and Q_{j2} (j=1, 2, ... k) from the second nut side are acting upon preloaded ball screws.

Action duration for these forces is indicated t_{i1} and t_{j2}. Nut (screw) turn quantity for these forces is indicated n_{i1} and n_{j2}.

Forces, acting for the first nut are indicated q'_{i1} and q''_{j2}; forces, acting for the second nut are indicated q''_{i1} and q''_{j2}. They are calculated as follows:

$$q'_{i1} = Q_{nom} \cdot 1 + \frac{Q_{i1}^2}{4Q_{nom}^2}, \quad q''_{i1} = q'_{i1} \cdot Q_{i1}$$

$$q'_{j2} = Q_{nom} \cdot 1 + \frac{Q_{j2}^2}{4Q_{nom}^2}, \quad q''_{j2} = q'_{j2} \cdot Q_{j2}$$

First nut equivalent load is calculated as follows:

$$Q_1 = \sqrt{\frac{\sum_{i=1}^k (q'_{i1})^3 n_{i1} t_{i1} + \sum_{j=1}^s (q'_{j2})^3 n_{j2} t_{j2}}{100n}}, \quad n = 0,01 \cdot \sum_{i=1}^k n_{i1} t_{i1} + \sum_{j=1}^s n_{j2} t_{j2}$$

n mean rotation rapidity by the constant load and variable swivel speed, rpm.

The equivalent load Q₂ for the second nut is calculated by analogy.

Preload force Q_H is calculated as follows:

$$Q_H = \frac{1,4 \cdot 10^5 M_{xx} r}{d_0} \cdot 10^5$$

M_{xx} drag torque, Nm;

d₀ rated ball screw diameter, mm;

r ball radius, mm.

Life of ball screws is determined periodically by stand tests to confirm calculation method, check new technical decisions or by change of material or technology used.

Life Calculation Example

$$Q_H = 6,7, \quad Q_{11} = 7, \quad Q_{21} = 10, \quad Q_{31} = 5, \quad Q_{41} = 0,3$$

$$Q_{12} = 4, \quad Q_{22} = 3$$

Axial forces $Q_{11}=7$ kN, $Q_{21}=10$ kN, $Q_{31}=5$ kN, $Q_{41}=0,3$ kN from the first nut side and axial forces $Q_{12}=4$ kN, $Q_{22}=3$ kN from the second nut side are acting upon ball screw with the preload of $Q_H=7$ kN.

Table shows action time of these forces per cent to overall time of ball screw operation and rotation speed of the screw.

The first nut has the main load, so its mean speed is been calculated as:

$$n = \frac{10 \cdot 40 + 20 \cdot 25 + 100 \cdot 20 + 1000 \cdot 20 + 500 \cdot 5 + 200 \cdot 5}{100} = 144 \text{ min}^{-1}$$

First nut equivalent load:

$$Q = \sqrt[3]{\frac{10,66^3 \cdot 10 \cdot 40 + 12,63^3 \cdot 20 \cdot 25 + 9,43^3 \cdot 100 \cdot 20 + 6,85^3 \cdot 1000 \cdot 5 + 4,85^3 \cdot 500 \cdot 5 + 5,88^3 \cdot 200 \cdot 5}{100 \cdot 144}} = 7,7$$

32x5, i=3,

3 :

For ball screw 32x5, i=3, ball diameter of 3 mm:

$$C = 17,7 \text{ kN}, \quad L = \frac{17,7^3}{7,7} \cdot 10^6 = 12,16 \cdot 10^6$$

Q_{i1} , kN	Q_{j2} , kN	t, %	n, min ⁻¹	q'_{i1} , kN	q'_{j2} , kN	q''_{j2} , kN
7		40	10	10,66		
10		25	20	12,63		
5		20	100	9,43		
0,3		5	1000	6,85		
	4	5	500		8,85	4,85
	3	5	200		8,28	5,28

