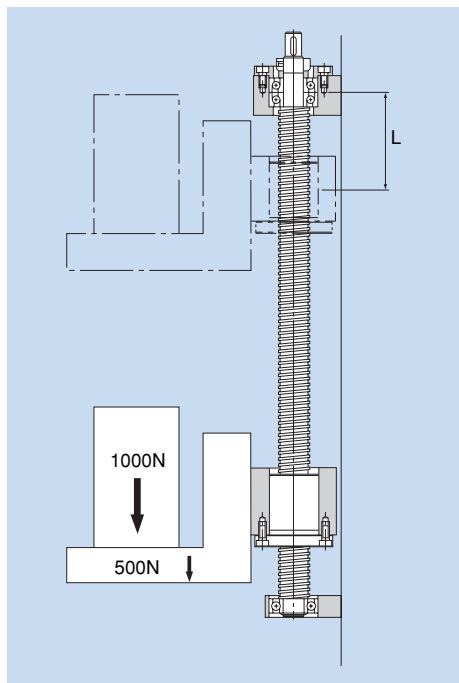


## 9.4. Studying the Axial Rigidity of the Feed Screw System

Of the axial rigidities of the feed screw system, the axial rigidity of the screw shaft fluctuates according to the stroke position. When the axial rigidity is large, such change in the axial rigidity of the screw shaft will affect the positioning accuracy. Therefore, it is necessary to take into account the rigidity of the feed screw system (pages K-58 to K-61).

Example: Positioning error due to the axial rigidity of the feed screw system during vertical transfer



[Service conditions]

Transferred weight: 1,000 N; table weight: 500 N

Ball Screw used: model BNF2512 - 2.5 (screw-shaft thread minor diameter  $d_1 = 21.9$  mm)

Stroke length: 600 mm ( $L = 100$  mm to 700 mm)

Screw shaft mounting type: fixed-supported

### ■ Consideration

The difference in axial rigidity between  $L = 100$  mm and  $L = 700$  mm applied only to the axial rigidity of the screw shaft. Therefore, positioning error due to the axial rigidity of the feed screw system equals to the difference in the axial displacement of the screw shaft between  $L = 100$  mm and  $L = 700$  mm.

### ■ Axial Rigidity of the Screw Shaft (see pages K-58 and K-59)

$$K_s = \frac{A \cdot E}{1000L} = \frac{376.5 \times 2.06 \times 10^5}{1000 \times L} = \frac{77.6 \times 10^3}{L}$$

$$A = \frac{\pi}{4} d_1^2 = \frac{\pi}{4} \times 21.9^2 = 376.5 \text{ mm}^2$$

$$E = 2.06 \times 10^5 \text{ N/mm}^2$$

① When  $L = 100 \text{ mm}$

$$K_{S1} = \frac{77.6 \times 10^3}{100} = 776 \text{ N/}\mu\text{m}$$

② When  $L = 700 \text{ mm}$

$$K_{S2} = \frac{77.6 \times 10^3}{700} = 111 \text{ N/}\mu\text{m}$$

### ■ Axial Displacement due to Axial Rigidity of the Screw Shaft

① When  $L = 100 \text{ mm}$

$$\delta_1 = \frac{Fa}{K_{S1}} = \frac{1000 + 500}{776} = 1.9 \mu\text{m}$$

② When  $L = 700 \text{ mm}$

$$\delta_2 = \frac{Fa}{K_{S2}} = \frac{1000 + 500}{111} = 13.5 \mu\text{m}$$

### ■ Positioning Error due to Axial Rigidity of the Feed Screw System

Positioning accuracy  $= \delta_1 - \delta_2 = 1.9 - 13.5$

$$= -11.6 \mu\text{m}$$

Therefore, the positioning error due to the axial rigidity of the feed screw system is  $11.6 \mu\text{m}$ .