Cross shaft

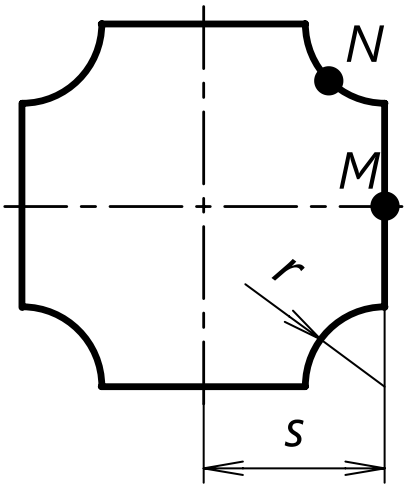

Fig. 1 - Cross shaft

Values for calculation:

Twisting moment	T	1000	Nm
Radius	r	15	mm
Dimension	s	35	mm
Length	L	1000	mm
Modulus of rigidity	G	80000	MPa

$$0 \leq \frac{r}{s} < 0.5 \rightarrow 0 \leq 0.429 < 0.5$$

Does suit.

$$C = 1.1266 - 0.321\frac{r}{s} + 3.1519\left(\frac{r}{s}\right)^2 - 14.347\left(\frac{r}{s}\right)^3 + 15.223\left(\frac{r}{s}\right)^4 - 4.7767\left(\frac{r}{s}\right)^5$$
$$= 1.1266 - 0.321\frac{15}{35} + 3.1519\left(\frac{15}{35}\right)^2 - 14.347\left(\frac{15}{35}\right)^3 + 15.223\left(\frac{15}{35}\right)^4 - 4.7767\left(\frac{15}{35}\right)^5$$
$$= 0.883$$

$$B_M = 0.601 + 0.1059\frac{r}{s} - 0.918\left(\frac{r}{s}\right)^2 + 3.7335\left(\frac{r}{s}\right)^3 - 2.8686\left(\frac{r}{s}\right)^4$$
$$= 0.601 + 0.1059\frac{15}{35} - 0.918\left(\frac{15}{35}\right)^2 + 3.7335\left(\frac{15}{35}\right)^3 - 2.8686\left(\frac{15}{35}\right)^4 = 0.675$$

$$B_N = -0.3281 + 9.1405\frac{r}{s} - 42.52\left(\frac{r}{s}\right)^2 + 109.04\left(\frac{r}{s}\right)^3 - 133.95\left(\frac{r}{s}\right)^4 + 66.054\left(\frac{r}{s}\right)^5$$
$$= -0.3281 + 9.1405\frac{15}{35} - 42.52\left(\frac{15}{35}\right)^2 + 109.04\left(\frac{15}{35}\right)^3 - 133.95\left(\frac{15}{35}\right)^4 + 66.054\left(\frac{15}{35}\right)^5$$
$$= 0.799$$

Polar moment of inertia:

$$K = 2Cr^4 = 2 \cdot 0.883 \cdot 15^4 = 89403.8\text{mm}^4$$

Angle of twist:

$$\theta = \frac{T \cdot 10^3 \cdot L}{KG} = \frac{1000 \cdot 10^3 \cdot 1000}{89403.8 \cdot 80000} = 0.14\text{rad}$$

Torsion stress:

$$\tau_{at\ M} = \frac{B_M \cdot 10^3 T}{s^3} = \frac{0.675 \cdot 10^3 \cdot 1000}{35^3} = 15.7\text{MPa}$$

$$\tau_{at\ N} = \frac{B_N \cdot 10^3 T}{s^3} = \frac{0.799 \cdot 10^3 \cdot 1000}{35^3} = 18.6\text{MPa}$$