Application Engineering advice on the use of cardan shafts

The following is intended, in particular, to help the design and project engineer develop optimum in-service condition for any intended use of cardan shafts and thereby obtain perfect functional reliability and a prolonged service life of the drive arrangement. It is often possible at the design stage to facilitate the incorporation of a universal drive, most desirably reasons, as a standard type. We should very pleased to counsel you on call your drive problem.

Deflection angle and service life

The distinguishing feature of a universal joint is its ability to transmit rotary motion at a constant or varying misalignment within a deflection angle of ± ß.

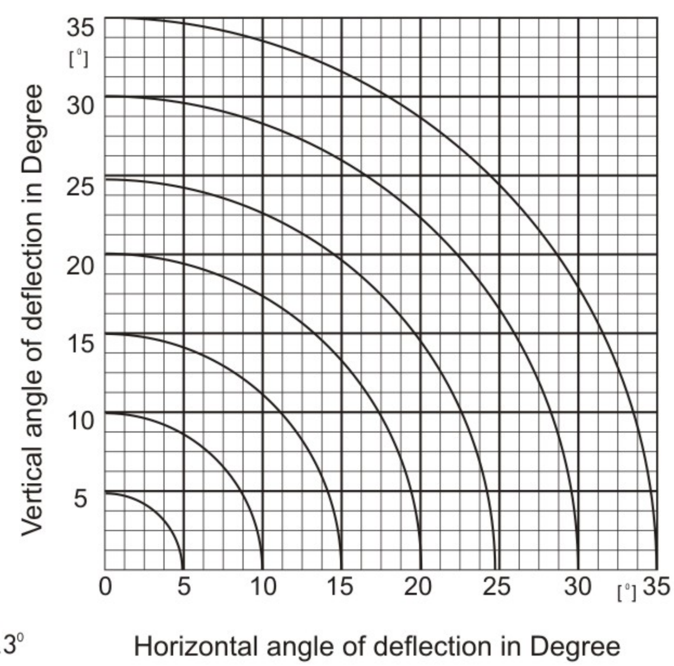
The deflection angle shown on the dimensional sheets can safely be obtained where special circumstances necessitate their use.

Generally, as an increase of ß reduces the lifetime of the joint bearing, the operating angle should be as small as possible, however not below 1° for maintaining a suffocation lubrication of the bearing.

Where a universal joint has angle in the horizontal and vertical planes at the same time, the resulting angle can be calculated from the components $ß_H$ and $ß_V$ or it can be gathered from the diagram, which gives sufficient accuracy in most cases.

$\tan ß = \sqrt{\tan^2 ß_H + \tan^2 ß_V}$ or it can be

Example : $ß_V = 25^0$; $ß_H = 15^0 \rightarrow ß = 28.3^0$



Kinematics

The universal joint works in accordance with a certain kinematical law:

With the driving shafts at a constant angular velocity ω_2. This angular velocity on the driven side passes through peaks and valleys twice per revolution, their absolute amounts progressively increasing with the deflection angle. With constant output, the torques are inversely proportional to the angular velocities, so that the resulting extremes for the driven shafts are as follows:

TURNING ANGLE	
0^0 and 180^0	90^0 and 270^0
$\omega_2 = \omega_1 \cos \beta$	$\omega_2 = \frac{\omega_1}{\cos \beta}$
$M_{t2} = \frac{M_{t1}}{\cos \beta}$	$M_{t2} = M_{t1} \cos \beta$

The kinematical unevenness is critical if two shafts positioned at an angle of deflection are linked by a single joint. The mid- section of a cardan shafts located between two joints can also induce vibration in the power train due to acceleration and deceleration. Small angles of deflection are therefore important also this shafts configuration; especially in the high-speed range therefore, to ensure that cardan shafts run smoothly and with little vibration, the product of n-ß (speed angle of deflection) should remain within empirical limits.

For orientation:

$$n.\beta \leq \frac{36000}{\sqrt[6]{m}} \quad \text{order/or} \quad n.\beta \sqrt[6]{m} \leq 36000$$

n = Speed [rpm] | ß = Deflection angle [0] | m = Mass of cardan shaft [kg]

Where a single joint is used, it is all-important to check that the differential angle of the dissimilar rotation and the resulting mass forces are within permissible limits for the given application.

The maximum differential angle of a single joint can be calculated by the following formula

$$\Delta\varphi \max = \pm \arctan \frac{1-\cos\beta}{2\sqrt{\cos\beta}}$$

An another term for the dissimilar rotation is the non-uniformity U. it is defined by:

$$U = \frac{\omega_{2\,max} - \omega_{2\,min}}{\omega_1} \quad \text{order / or } U = \sin\beta - \tan\beta$$

The operating speed should not exceed 80% of the critical speed calculated, otherwise the application would require, instead of one cardan shafts with an intermediate bearing, a so called train of cardan shafts. This involves certain require-ments with respect to the deflection angle.

For advice contact our design engineers.

Limitations of length and speed

The length of tubular cardan shafts is limited by the speed beyond which deflection is likely, or simply by the limits set in production.

The largest length, which is available and can be balanced is L=6000 mm. request.