Autodesk Inventor Engineer s Handbook

هندبوک مهندسی نرم افزار Autodesk Inventor

انجمن اینونتور ایران

www.irinventor.com

Email: irinventor@chmail.ir
irinventor@hotmail.com

Tel: 09352191813 &

021-46088862

Joints / Movable Joints

Parallel Spines Generator

Spline calculations in metric units

Transferred torque

$$T = \frac{30 \cdot 10^3 \cdot P}{\pi \cdot n} \qquad [Nm]$$

where:

Ptransferred power [kW]

nspeed [rpm]

Pressure on groove supporting surface

1. shaft inside diameter $d_h > 0$

a)
$$d_{min} = 3\sqrt{\frac{16 \cdot T \cdot K_a \cdot S_v}{\pi \cdot \tau_A \cdot K_f}} \quad [mm]$$

b) if $d_{min} \leq d_h$ -> $d_{min} = 1.1\, d_h$ [mm]

c) if $d_{min} \leq 1.5\, d_h$ -> $d_{min} = 1.5\, d_h$ [mm]

2. shaft inside diameter $d_h = 0$

$$d_{min} = 3\sqrt{\frac{16 \cdot T \cdot K_a \cdot S_v}{\pi \cdot \tau_A \cdot K_f}} \quad [mm]$$

where:

d_{min} minimal shaft diameter [mm]

d_h shaft inside diameter [mm]

T torque [Nm]

K_a application factor

K_f fatigue-life factor

S_v desired safety

τ_{Al} Allowable Shear Stress

Minimum splines length to transfer the torque

1. Fixed connection: $$L_{min} = \frac{T \cdot 10^3 \cdot K_a \cdot S_v}{d_s \cdot p_{D\min} \cdot \frac{h_{st}}{2} \cdot N \cdot K_m \cdot K_f} \quad [mm]$$

2. Flexible connection: $$L_{min} = \frac{T \cdot 10^3 \cdot K_a \cdot S_v}{d_s \cdot p_{D\min} \cdot \frac{h_{st}}{2} \cdot N \cdot K_m \cdot K_w} \quad [mm]$$

where:

T	torque [Nm]
K_a	application factor
K_f	wear-life factor
K_w	application factor
K_m	load distribution factor
S_v	desired safety
d_s	middle diameter = (D + d) / 2 [mm]
D	outside diameter of groove section [mm]
d	inside diameter of groove section [mm]
N	number of grooves [-].
h	height of groove = (D - d) / 2 [mm]
s	chamfer
h_{st}	connection height h_{st} = h - 2 s [mm]

p_{Dmin} allowable pressure on supporting surface of shaft or groove [MPa]

Allowable pressure

1. Fixed connection: $$p_{min} = \frac{T \cdot 10^3 \cdot K_a}{d_s \cdot l_f \cdot \frac{h_{st}}{2} \cdot N \cdot K_m \cdot K_f} \quad [MPa]$$

2. Flexible connection: $$p_{min} = \frac{T \cdot 10^3 \cdot K_a}{d_s \cdot l_f \cdot \frac{h_{st}}{2} \cdot N \cdot K_m \cdot K_w} \quad [MPa]$$

where:

T	torque [Nm]
K_a	application factor
K_f	wear-life factor
K_w	application factor
K_m	load distribution factor
S_v	desired safety
d_s	middle diameter = (D + d) / 2 [mm]
D	outside diameter of groove section [mm]
d	inside diameter of groove section [mm]
N	number of grooves [-].
h	height of groove = (D - d) / 2 [mm]
s	chamfer
h_{st}	connection height h_{st} = h - 2 s [mm]
l_f	active key length [mm]

Strength Check

$p_{min} \leq p_{ds}$

$p_{min} \leq p_{dh}$

where:

p_{min} minimal calculated h/2 pressure [MPa]

p_{ds} allowable pressure in shaft [Mpa]

p_{dh} allowable pressure in hub [Mpa]

Spline calculations in English units

Transferred torque

$$T = \frac{30 \cdot 550 \cdot P}{\pi \cdot n} \quad [lb\ ft]$$

where:

Ptransferred power [lb ft]

nspeed [min^{-1}]

Pressure on groove supporting surface

1. shaft inside diameter $d_h > 0$

a)
$$d_{min} = 3\sqrt{\frac{16 \cdot T \cdot K_a \cdot S_y}{\pi \cdot \tau_A \cdot K_f}} \quad [in]$$

b) if $d_{min} \leq d_h$ -> $d_{min} = 1.1\ d_h$ [mm]

c) if $d_{min} \leq 1.5\ d_h$ -> $d_{min} = 1.5\ d_h$ [mm]

2. shaft inside diameter $d_h = 0$

$$d_{min} = 3\sqrt{\frac{16 \cdot T \cdot K_a \cdot S_y}{\pi \cdot \tau_A \cdot K_f}} \quad [in]$$

where:

d_{min}minimal shaft diameter [in]

d_h shaft inside diameter [inm]

T torque [lbft]

K_a application factor

K_f fatigue-life factor

S_v desired safety

τ_{Al} Allowable Shear Stress

Minimum splines length to transfer the torque

1. Fixed connection: $$L_{min} = \frac{T \cdot 12 \cdot K_a \cdot S_v}{d_s \cdot p_{D\,min} \cdot \frac{h_{st}}{2} \cdot N \cdot K_m \cdot K_f} \quad [in]$$

2. Flexible connection: $$L_{min} = \frac{T \cdot 12 \cdot K_a \cdot S_v}{d_s \cdot p_{D\,min} \cdot \frac{h_{st}}{2} \cdot N \cdot K_m \cdot K_w} \quad [in]$$

where:

T	torque [lbft]
K_a	application factor
K_f	wear-life factor
K_w	application factor
K_m	load distribution factor
S_v	desired safety
d_s	middle diameter = (D + d) / 2 [in]
D	outside diameter of groove section [in]
d	inside diameter of groove section [in]
N	number of grooves [-]
h	height of groove = (D - d) / 2 [in]
s	chamfer

h_{st}	connection height $h_{st} = h - 2\,s$ [inm]
p_{Dmin}	allowable pressure on supporting surface of shaft or groove [psi]

Allowable pressure

1. Fixed connection: $$p_{min} = \frac{T \cdot 12 \cdot K_a}{d_s \cdot l_f \cdot \frac{h_{st}}{2} \cdot N \cdot K_m \cdot K_f} \quad [psi]$$

2. Flexible connection: $$p_{min} = \frac{T \cdot 12 \cdot K_a}{d_s \cdot l_f \cdot \frac{h_{st}}{2} \cdot N \cdot K_m \cdot K_w} \quad [psi]$$

where:

T	torque [lb ft]
K_a	application factor
K_f	wear-life factor
K_w	application factor
K_m	load distribution factor
S_v	desired safety
d_s	middle diameter = (D + d) / 2 [in]
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N	number of grooves [-]
h	height of groove = (D - d) / 2 [in]
s	chamfer
h_{st}	connection height $h_{st} = h - 2\,s$ [in]
l_f	active key length [in]

Strength Check

$p_{min} \leq p_{ds}$

$p_{min} \leq p_{dh}$

where:

p_{min} minimal calculated h/2 pressure [psi]

p_{ds} allowable pressure in shaft [psi]

p_{dh} allowable pressure in hub [psi]

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Email: irinventor@chmail.ir
& irinventor@hotmail.com

Tel: 09352191813 & 021-46088862