## 5 The Technical Dimensioning of the Conveyor Chain

### 5.1 Calculation Parameters

<table>
<thead>
<tr>
<th>Designation</th>
<th>Symbol</th>
<th>Unit</th>
<th>Designation</th>
<th>Symbol</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total tensile force of chain</td>
<td>F</td>
<td>N</td>
<td>Filling ratio</td>
<td>φ</td>
<td>----</td>
</tr>
<tr>
<td>Circumferential tensile force of chain, total</td>
<td>$F_g$</td>
<td>N</td>
<td>Coefficient of friction between bush and roller</td>
<td>$\mu_3$</td>
<td>----</td>
</tr>
<tr>
<td>Circumferential tensile force of chain, per chain strand</td>
<td>$F_l$</td>
<td>N</td>
<td>Sagging of slack strand</td>
<td>$f$</td>
<td>m</td>
</tr>
<tr>
<td>Supporting tensile force of chain (depending on sagging)</td>
<td>$F_s$</td>
<td>N</td>
<td>Coefficient of friction (conveyed material to steel)</td>
<td>$\mu_4$</td>
<td>----</td>
</tr>
<tr>
<td>Centrifugal tensile force of chain</td>
<td>$F_r$</td>
<td>N</td>
<td>Distance of unit load</td>
<td>$l_s$</td>
<td>m</td>
</tr>
<tr>
<td>Pretension force of chain</td>
<td>$F_v$</td>
<td>N</td>
<td>Coefficient of rolling resistance</td>
<td>$\mu_2$</td>
<td>----</td>
</tr>
<tr>
<td>Breaking load of chain</td>
<td>$F_b$</td>
<td>N</td>
<td>Chain velocity</td>
<td>$v$</td>
<td>m/s</td>
</tr>
<tr>
<td>Number of chain strands</td>
<td>$i$</td>
<td>----</td>
<td>Coefficient of sliding friction</td>
<td>$\mu_1$</td>
<td>----</td>
</tr>
<tr>
<td>Conveying height</td>
<td>$H$</td>
<td>m</td>
<td>Articulation surface of chain</td>
<td>$A_k$</td>
<td>cm²</td>
</tr>
<tr>
<td>Conveying length, horizontal</td>
<td>$B$</td>
<td>m</td>
<td>Slack distance</td>
<td>$a_d$</td>
<td>m</td>
</tr>
<tr>
<td>Distance between axes</td>
<td>$a$</td>
<td>m</td>
<td>Safety factor</td>
<td>$k$</td>
<td>----</td>
</tr>
<tr>
<td>Angle of inclination of conveyor</td>
<td>$\alpha$</td>
<td>(degrees)</td>
<td>Chain length of slack strand</td>
<td>$l_d$</td>
<td>m</td>
</tr>
<tr>
<td>Mass of chain per m of chain</td>
<td>$M_K$</td>
<td>kg/m</td>
<td>Articulation surface pressure, effective</td>
<td>$P_{eff}$</td>
<td>N/mm²</td>
</tr>
<tr>
<td>Mass of materials to be conveyed per m of chain</td>
<td>$M_F$</td>
<td>kg/m</td>
<td>Articulation surface pressure, admissible</td>
<td>$P_{zul}$</td>
<td>N/mm²</td>
</tr>
<tr>
<td>Conveyor capacity (pieces)</td>
<td>$Q_S$</td>
<td>St/h</td>
<td>Chain pitch</td>
<td>$p$</td>
<td>m</td>
</tr>
<tr>
<td>Conveyor capacity (mass)</td>
<td>$Q_M$</td>
<td>t/h</td>
<td>Angular velocity</td>
<td>$\omega$</td>
<td>s⁻¹</td>
</tr>
<tr>
<td>Trough width of conveyor</td>
<td>$b$</td>
<td>m</td>
<td>Number of teeth</td>
<td>$z$</td>
<td>----</td>
</tr>
<tr>
<td>Trough height of conveyor</td>
<td>$h$</td>
<td>m</td>
<td>Pitch diameter</td>
<td>$d_0$</td>
<td>m</td>
</tr>
<tr>
<td>Cross-sectional area of conveyor</td>
<td>$A_M$</td>
<td>m²</td>
<td>Motor output of drive</td>
<td>$P$</td>
<td>kW</td>
</tr>
<tr>
<td>Mass of bulk material to be conveyed</td>
<td>$\gamma$</td>
<td>t/m³</td>
<td>Efficiency of drive</td>
<td>$\eta$</td>
<td>----</td>
</tr>
</tbody>
</table>
5.2 Types of Conveyor

The conveyors are subdivided in two main categories:

- Sliding conveyor chains
- Rolling conveyor chains

They are furthermore classified according to the following arrangement criteria:

- Horizontal conveyance
- Oblique conveyance
- Vertical conveyance
- Combined conveyance

5.3 Total Mass of the Material to be conveyed

This is the total mass of the material to be conveyed, which is resting and is to be moved on the conveyor chains or on possibly existing supporting elements (plates, transverse bars, cross-rails, slat bands, etc.).

According to the load distribution on the conveyor chain, a difference is to be made between point, individual and linear loading. If the load is concentrated on a reduced area, the chain pins and rollers have to be recalculated concerning deflexion and pressure, respectively, when dimensioning the conveyor chain.

5.4 Load Carrying Capacity of the Rollers

The load carrying capacity of the rollers depends on the roller material, the type of bearing, the chain velocity, the temperature, and the lubrication. For surface-hardened steel rollers, with a low chain velocity (< 0.25 m/s) and a sufficient surface pressure, up to 800 N/cm² are admissible.

If rollers are made of quenched and tempered or of unhardened steel, of grey cast iron or of synthetic material, lower bearing contact pressures are admissible (compare the following tables).

Advantages of synthetic rollers are:

- No maintenance
- Lightweight construction
- Silent run
- High chemical resistance

It is furthermore possible to improve the sliding properties of the rollers by means of bearing bushes. A suitable bearing material is lead tin bronze (surface pressures up to 300 N/cm²), but also special bearing materials are appropriate for a low-maintenance operation.

The following tables 3a and b show admissible roller loads for conveyor chains according to DIN 8165 and DIN 8167, which have to be multiplied by the corresponding correction factors from tables 4 to 8, using the formulae indicated:

\[
\text{Admissible load of the roller} = \text{table value} \cdot f_1 \cdot f_2 \cdot f_3 \cdot f_4 \cdot f_5
\]
<table>
<thead>
<tr>
<th>Chain according to DIN 8165</th>
<th>Mating of material Bush / Roller C15E / C15E C15E / 9SMn28E</th>
<th>Chain according to DIN 8167</th>
<th>Mating of material Bush / Roller C15E / C15E C15E / 9SMn28E</th>
</tr>
</thead>
<tbody>
<tr>
<td>FVT 40</td>
<td>2000</td>
<td>MT 20</td>
<td>1050</td>
</tr>
<tr>
<td>FVT 63</td>
<td>3000</td>
<td>MT 28</td>
<td>1350</td>
</tr>
<tr>
<td>FVT 90</td>
<td>3800</td>
<td>MT 40</td>
<td>1900</td>
</tr>
<tr>
<td>FVT 112</td>
<td>5100</td>
<td>MT 56</td>
<td>2750</td>
</tr>
<tr>
<td>FVT 140</td>
<td>7050</td>
<td>MT 80</td>
<td>3850</td>
</tr>
<tr>
<td>FVT 180</td>
<td>10550</td>
<td>MT 112</td>
<td>5200</td>
</tr>
<tr>
<td>FVT 250</td>
<td>15650</td>
<td>MT 160</td>
<td>7200</td>
</tr>
<tr>
<td>FVT 315</td>
<td>21500</td>
<td>MT 224</td>
<td>10050</td>
</tr>
<tr>
<td>FVT 400</td>
<td>23900</td>
<td>MT 315</td>
<td>13500</td>
</tr>
<tr>
<td>FVT 500</td>
<td>31200</td>
<td>MT 450</td>
<td>18450</td>
</tr>
<tr>
<td>FVT 630</td>
<td>39400</td>
<td>MT 630</td>
<td>26000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MT 900</td>
<td>36450</td>
</tr>
</tbody>
</table>

Tab. 3: Loadability of rollers (N/Roller) for carrying roller chains according to DIN 8165 and DIN 8167

<table>
<thead>
<tr>
<th>Roller type</th>
<th>f₁</th>
<th>Roller material (bush of case-hardened steel, hardened)</th>
<th>f₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roller</td>
<td>1.0</td>
<td>Case-hardened steel, hardened</td>
<td>1.0</td>
</tr>
<tr>
<td>Flanged roller</td>
<td>0.9</td>
<td>Stainless steel, hardened</td>
<td>0.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Stainless steel, unhardened</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Standard steel, unhardened</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Grey cast iron</td>
<td>0.12</td>
</tr>
</tbody>
</table>

Tab. 4: Factor f₁ : Roller type

<table>
<thead>
<tr>
<th>Lubricating conditions</th>
<th>f₃</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sufficient lubrication, no dirt or rough operating conditions</td>
<td>1.0</td>
</tr>
<tr>
<td>Insufficient lubrication, no dirt or rough operating conditions</td>
<td>0.4 - 0.6</td>
</tr>
<tr>
<td>Without lubrication, with much dirt and rough operating conditions</td>
<td>0.2 - 0.35</td>
</tr>
</tbody>
</table>

Tab. 6: Factor f₃ : Lubrication

<table>
<thead>
<tr>
<th>Chain velocity in m/s</th>
<th>f₄</th>
<th>Temperature in °C</th>
<th>f₅</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.10</td>
<td>1.15</td>
<td>20 - 200</td>
<td>1.00</td>
</tr>
<tr>
<td>0.25</td>
<td>1.00</td>
<td>200 - 260</td>
<td>0.50</td>
</tr>
<tr>
<td>0.50</td>
<td>0.85</td>
<td>260 - 285</td>
<td>0.25</td>
</tr>
<tr>
<td>1.00</td>
<td>0.50</td>
<td>285 - 300</td>
<td>0.15</td>
</tr>
</tbody>
</table>

Tab. 7: Factor f₄ : Chain velocity

<table>
<thead>
<tr>
<th>Mating of material</th>
<th>Max. specific bearing contact pressure in N/cm²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roller</td>
<td>Bush</td>
</tr>
<tr>
<td>Case-hardened steel, hardened</td>
<td>800</td>
</tr>
<tr>
<td>Quenched and tempered steel</td>
<td>300</td>
</tr>
<tr>
<td>Unhardened steel</td>
<td>160</td>
</tr>
<tr>
<td>Grey cast iron</td>
<td>100</td>
</tr>
<tr>
<td>Bronze</td>
<td>300</td>
</tr>
<tr>
<td>Polyamide 6</td>
<td>50</td>
</tr>
</tbody>
</table>

Tab. 9: Admissible maximum values of specific pressing
5.5 Coefficients of Friction

5.5.1 Sliding Friction of Chains on a Base in Continuous Operation

<table>
<thead>
<tr>
<th>Material of slide rail</th>
<th>Insufficient lubrication</th>
<th>Good lubrication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel</td>
<td>0,35</td>
<td>0,25</td>
</tr>
<tr>
<td>Synthetic material</td>
<td>0,20</td>
<td>0,15</td>
</tr>
<tr>
<td>Hardwood</td>
<td>0,30</td>
<td>0,25</td>
</tr>
</tbody>
</table>

Tab. 10: Coefficient of sliding friction \( \mu_1 \)

5.5.2 Rolling Friction of Chains on Steel Guides

Coeficient of rolling resistance \( \mu_2 = \frac{2 \cdot c + \mu_3 \cdot d_3}{d_5} \)

\( \mu_2 = 0,08...0,12...0,18 \)

\( d_3 = \) bush diameter [mm]
\( d_5 = \) roller diameter [mm]
\( c = \) experimental coefficient, depending on material and the surface roughness of the areas of contact

Conditions of guide \( c \)

0.5 Steel roller on steel guide with smooth surface
0.6 Mean value
1.0 Steel roller on steel guide with rough surface

Tab. 11: Coefficient \( c \) in dependence on material and contact surface

<table>
<thead>
<tr>
<th>Matting of material Roller / bush</th>
<th>Insufficient lubrication</th>
<th>Good lubrication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel roller on steel bush</td>
<td>0,30</td>
<td>0,20</td>
</tr>
<tr>
<td>Roller with bronze bush on steel bush</td>
<td>-</td>
<td>0,15</td>
</tr>
<tr>
<td>PA6 roller on steel bush</td>
<td>0,15</td>
<td>0,10</td>
</tr>
<tr>
<td>Roller with rolling bearing on steel bush</td>
<td>0,03</td>
<td>0,015 ... 0,005</td>
</tr>
</tbody>
</table>

Tab. 12: Coefficient of friction between roller and bush \( \mu_3 \)

5.5.3 Coefficient of Friction between Material to be conveyed and Steel \( \mu_4 \), Bulk Weight \( \gamma \) and Filling Ratio \( \phi \)

<table>
<thead>
<tr>
<th>Type of material to be conveyed</th>
<th>Coefficient of friction ( \mu_4 )</th>
<th>Bulk weight ( \gamma ) in t/m³</th>
<th>Filling ratio ( \phi )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ash</td>
<td>0,85</td>
<td>0,50</td>
<td>0,70</td>
</tr>
<tr>
<td>Ore</td>
<td>1,20</td>
<td>2,25</td>
<td>0,60</td>
</tr>
<tr>
<td>Cereals</td>
<td>0,50</td>
<td>0,65</td>
<td>0,80</td>
</tr>
<tr>
<td>Wood chips</td>
<td>0,80</td>
<td>0,25</td>
<td>0,75</td>
</tr>
<tr>
<td>Gravel</td>
<td>1,00</td>
<td>1,75</td>
<td>0,65</td>
</tr>
<tr>
<td>Coal</td>
<td>0,90</td>
<td>0,80</td>
<td>0,50</td>
</tr>
<tr>
<td>Coke</td>
<td>1,00</td>
<td>0,45</td>
<td>0,60</td>
</tr>
<tr>
<td>Loam</td>
<td>0,75</td>
<td>1,25</td>
<td>0,70</td>
</tr>
<tr>
<td>Flour</td>
<td>0,50</td>
<td>0,60</td>
<td>0,70</td>
</tr>
<tr>
<td>Sand</td>
<td>0,80</td>
<td>1,55</td>
<td>0,60</td>
</tr>
<tr>
<td>Broken stone</td>
<td>0,65</td>
<td>1,80</td>
<td>0,65</td>
</tr>
<tr>
<td>Peat</td>
<td>0,70</td>
<td>0,40</td>
<td>0,80</td>
</tr>
<tr>
<td>Cement</td>
<td>0,65</td>
<td>1,20</td>
<td>0,70</td>
</tr>
</tbody>
</table>

Tab. 13: Coefficient of friction - material to be conveyed / steel, bulk weight and filling ratio
5.6 Calculation of the Total Tensile Force of Chain F

The total tensile force of a chain F results from the sum of the total circumferential tensile force \( F_g \), the supporting tensile force of chain \( F_s \), and the centrifugal tensile force of chain \( F_r \).

\[
F = F_g + F_s + F_r
\]

5.6.1 Chain Supporting Tensile Force \( F_s \)

The supporting tensile force of the chain is produced when the chain is freely sagging and depends on the dead weight of the chain and the chain length of the sagging slack strand.

\[
F_s = \frac{M_K \cdot 9.81 \cdot a_d^2}{8 \cdot f} \cdot \sqrt{1 + 16 \cdot \frac{f^2}{a_d^2}}
\]

Sag f results from the following equation:

\[
f = \sqrt{0.375 \cdot a_d \cdot (l_d - a_d)} \quad (f \text{ selected should be } \approx 10\% \text{ of } a_d)
\]

5.6.2 Chain Centrifugal Tensile Force \( F_r \)

The centrifugal tensile force of the chain is a tensile force depending on the chain velocity \( v \) and the chain wheel diameter, which, as a component of the total tensile force of the chain, is to be considered above all in the case of higher chain velocities.

\[
F_r = M_K \cdot v^2
\]

where \( v = \omega \cdot \frac{d_0}{2} \), \( \omega = 2 \cdot p \cdot n \) (\( n \) = number of revolutions of the chain wheel in \( \text{s}^{-1} \))

5.6.3 Chain Circumferential Tensile Force \( F_g \)

The circumferential tensile force (effective power) results from the operating load dependent torque of the chain drive to be transmitted. In the following you will find some formulae for the calculation of the total circumferential tensile force \( F_g \) in dependence of the conveyor type. If the conveyor includes various chain strands, the chain circumferential tensile force per strand \( F_i \) results from the relation:

\[
F_i = \frac{F_g}{i}
\]
Sliding Friction

\[ F_g = 1.1 \cdot \mu \cdot 9.81 \cdot (2 \cdot M_K + M_F) \]
\[ F_v = 2.2 \cdot (F_g + a \cdot \mu \cdot 9.81 \cdot M_K) \]

\[ F_g = 11 \cdot a \cdot 9.81 \left[ (M_K + M_F) \cdot (\mu \cdot \cos \alpha + \sin \alpha) + M_K \cdot (\mu \cdot \cos \alpha - \sin \alpha) \right] \]
if \( (\mu \cdot \cos \alpha - \sin \alpha) < 0 \):
\[ F_g = 11 \cdot a \cdot 9.81 \left( M_K + M_F \right) \cdot (\mu \cdot \cos \alpha + \sin \alpha) \]

\[ F_v = 2.2 \cdot F_g \quad \text{... if} \quad H/B > \mu_1 \]
\[ F_v = 2.2 \left[ F_g + 9.81 \cdot M_K \cdot (B \cdot \mu_1 - H) \right] \quad \text{... if} \quad H/B < \mu_1 \]

Rolling Friction

\[ F_g = 1.1 \cdot \mu_2 \cdot 9.81 \cdot (2 \cdot M_K + M_F) \]
\[ F_v = 2.2 \cdot (F_g + a \cdot \mu_2 \cdot 9.81 \cdot M_K) \]

\[ F_g = 11 \cdot a \cdot 9.81 \left[ (M_K + M_F) \cdot (\mu \cdot \cos \alpha + \sin \alpha) + M_K \cdot (\mu \cdot \cos \alpha - \sin \alpha) \right] \]
if \( (\mu \cdot \cos \alpha - \sin \alpha) < 0 \):
\[ F_g = 11 \cdot a \cdot 9.81 \left( M_K + M_F \right) \cdot (\mu \cdot \cos \alpha + \sin \alpha) \]

\[ F_v = 2.2 \cdot F_g \quad \text{... if} \quad H/B > \mu_2 \]
\[ F_v = 2.2 \left[ F_g + 9.81 \cdot M_K \cdot (B \cdot \mu_2 - H) \right] \quad \text{... if} \quad H/B < \mu_2 \]

Trough Chain Conveyor

\[ F_g = 11 \cdot a \cdot 9.81 \left( 2 \cdot M_K \cdot \mu_1 + \frac{Q_M}{3.6 \cdot v} \cdot \mu_4 \right) \]
\[ F_v = 2.2 \cdot (F_g + a \cdot \mu_1 \cdot 9.81 \cdot M_K) \]

\[ F_g = 11 \cdot a \cdot 9.81 \left[ M_K \cdot (\mu \cdot \cos \alpha + \sin \alpha) + \frac{Q_M}{3.6 \cdot v} \cdot (\mu \cdot \cos \alpha + \sin \alpha) + \frac{Q_M}{3.6 \cdot v} \cdot (\mu \cdot \cos \alpha - \sin \alpha) \right] \]
if \( (\mu \cdot \cos \alpha - \sin \alpha) < 0 \):
\[ F_g = 11 \cdot a \cdot 9.81 \left[ M_K \cdot (\mu \cdot \cos \alpha + \sin \alpha) + \frac{Q_M}{3.6 \cdot v} \cdot (\mu \cdot \cos \alpha + \sin \alpha) \right] \]

\[ F_v = 2.2 \cdot F_g \quad \text{... if} \quad H/B > \mu_1 \]
\[ F_v = 2.2 \left[ F_g + 9.81 \cdot M_K \cdot (B \cdot \mu_1 - H) \right] \quad \text{... if} \quad H/B < \mu_1 \]
5.7 Calculation of the Chain Breaking Load $F_b$ required

$$F_b = k \cdot F_i$$

Safety factor $k$

$$k = 5 \ldots 12$$

The safety factor $k$ depends mainly on the operational conditions and the number of teeth of the chain wheel. Generally, $k$ is about 6 to 7.

5.8 Calculation of the Driving Power $P$

$$P = \frac{F \cdot v}{1000 \cdot \eta}$$

where $\eta = 0.75 \ldots 0.8 \ldots 0.9$

5.9 Calculation of the Articulation Surface Pressure $P_{eff}$

$$P_{eff} = \frac{F}{A_K}$$

Diagram for $P_{zul}$

![Diagram for $P_{zul}$](image)

Fig. 7: Articulation surface pressure
5.10 Examples of Calculation

Example 1: Trough conveyor, horizontal

Material to be conveyed : Wood chips  
Conveying length : 40 m  
Conveyor capacity : 25 t/h  
Trough width of conveyor : 400 mm  
Trough height of conveyor : 300 mm  
Number of chain strands : 1  
Number of teeth of chain wheel : 8

a) Calculation of the chain velocity

\[ Q_M = 3600 \cdot v \cdot A_M \cdot \gamma \]

\[ v = \frac{Q_M}{3600 \cdot A_M \cdot \gamma} \]

\[ A_M = b \cdot h \cdot \varphi \]

\[ A_M = 0.4 \cdot 0.3 \cdot 0.75 \]

\[ A_M = 0.09 \text{ m}^2 \]

\[ Q_M = 25 \text{ m}^3/\text{h} \]

\[ \gamma = 0.25 \text{ (see section 4.5.3)} \]

\[ \varphi = 0.75 \text{ (see section 4.5.3)} \]

\[ b = 0.4 \text{ m} \]

\[ h = 0.3 \text{ m} \]

\[ v = \frac{25}{3600 \cdot 0.09 \cdot 0.25} = 0.31 \text{ m/s} \]

b) Calculation of the chain tensile force

\[ F_g = 1.1 \cdot a \cdot 9.81 \left(2 \cdot M_K \cdot \mu_1 + \frac{Q_M}{36 \cdot v} \cdot \mu_4 \right) \]

\[ F_g = 1.1 \cdot 40 \cdot 9.81 \left(2 \cdot 8 \cdot 0.35 + \frac{25}{36 \cdot 0.31} \cdot 0.8 \right) \]

\[ F_g = 10150 \text{ N} \]

\[ F_i = \frac{F_g}{i} = \frac{10150}{1} = F \text{ (} F_s \text{ and } F_t \text{ negligible) } \]

\[ F_b = k \cdot F = 7 \cdot 10150 = 71050 \text{ N} \]

\( \Rightarrow \) 1. assumption: Selection of the trough conveyor chain TF 90 according to table on page 50 

Standard pitch: \( p = 125 \text{ mm} \)

c) Recalculation of chain considering articulation surface pressure

\[ P_{\text{eff}} = \frac{F}{A_K} \leq P_{zul} \]

\[ F = 10150 \text{ N} \]

\[ A_K = 5 \text{ cm}^2 \text{ (see table on page 50)} \]

\[ P_{zul} = 2500 \text{ N/cm}^2 \text{ (see section 4.9)} \]

\[ P_{\text{eff}} = \frac{10150}{5} = 2030 \text{ N/cm}^2 < 2500 \text{ N/cm}^2 \]

Chain size TF90 selected correctly!
Example 1: Trough conveyor, horizontal - continuation

d) Calculation of chain pretensioning force

\[ F_v = 2.2 \cdot (F_s + a \cdot \mu_1 \cdot 9.81 \cdot M_K) \]
\[ F_s = 0 \text{ (as slack strand is supported)} \]
\[ a = 40 \text{ m} \]
\[ M_K = 8 \text{ kN/m} \]
\[ \mu_1 = 0.35 \text{ (see section 4.5.1)} \]

\[ F_v = 2420 \text{ N} \]

e) Driving power required

\[ P = \frac{F \cdot v}{1000 \cdot \eta} \]
\[ F = 10150 \text{ N} \]
\[ v = 0.31 \text{ m/s} \]
\[ \eta = 0.8 \]

\[ P = \frac{10150 \cdot 0.31}{1000 \cdot 0.8} = 3.9 \text{ kW} \]

Example 2: Conveyance of pallets

<table>
<thead>
<tr>
<th>Material to be conveyed</th>
<th>Pallets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conveying length</td>
<td>30 m</td>
</tr>
<tr>
<td>Pallet size</td>
<td>Length: 1200 mm, width: 800 mm</td>
</tr>
<tr>
<td>Total mass per pallet</td>
<td>600 kg</td>
</tr>
<tr>
<td>Number of chain strands</td>
<td>2</td>
</tr>
<tr>
<td>Chain velocity</td>
<td>0.2 m/s</td>
</tr>
<tr>
<td>Number of teeth of chain wheel</td>
<td>10</td>
</tr>
<tr>
<td>Max. number of pallets</td>
<td>20</td>
</tr>
<tr>
<td>Chain type selected</td>
<td>Carrying roller chain according to DIN 8165</td>
</tr>
</tbody>
</table>

a) Calculation of the chain tensile force

\[ F_g = 11 \cdot a \cdot \mu_2 \cdot 9.81 \cdot (2 \cdot M_K + M_F) \]
\[ a = 30 \text{ m} \]
\[ \mu_2 = 0.12 \text{ (estimated, see section 4.5.2)} \]

\[ F_g = 11 \cdot 30 \cdot 0.12 \cdot 9.81 \cdot (2 \cdot 11 + 400) \]
\[ F_g = 16400 \text{ N} \]

\[ F_i = \frac{F_g}{2} = \frac{16400}{2} = 8200 \text{ N} \]

\[ M_K = 2 \cdot 5.5 \text{ kN/m} = 11 \text{ kN/m} \]

\[ M_F = \frac{20 \text{ St} \cdot 600 \text{ kg/piece}}{30 \text{ m}} \]

\[ M_F = \frac{400 \text{ kg}}{30 \text{ m}} \]

\[ k = 7 \]

\[ F_b = k \cdot F_i \]
\[ F_b = 7 \cdot 8200 = 57400 \text{ N} \]

Selection of the chain type FVT 63, with a minimum breaking load of 63 kN (see table on page 44)
Example 2: Conveyance of pallets - continuation

b) Recalculation of chain considering articulation surface pressure

\[ P_{\text{eff}} = \frac{F_i}{A_k} \leq P_{\text{zul}} \]
\[ F_i = 8200 \text{ N} \]
\[ A_k = 3,7 \text{ cm}^2 \] (see tables on pages 44 and 45)
\[ P_{\text{zul}} = 2780 \frac{\text{ N}}{\text{ cm}^2} \] (see section 4.9)

\[ P_{\text{eff}} = \frac{8200}{3,7} = 2220 \frac{\text{ N}}{\text{ cm}^2} \leq 2780 \frac{\text{ N}}{\text{ cm}^2} \]

\[ P^r_{\text{zur}} = 2780 \frac{\text{ N}}{\text{ cm}^2} \]

\[ P^r_{\text{zur}} = 2780 \frac{\text{ N}}{\text{ cm}^2} \]

\[ \text{c) Recalculation of roller load} \]

Number of carrying rollers : 4
Chain pitch : 100 mm
Pallet mass : 600 kg

Existing roller load : \[ \frac{600 \cdot 9.81}{4} = 1472 \frac{\text{ N}}{\text{ roller}} \]
Admissible roller load : see section 4.4

Carrying roller chain FVT 63 : \[ 3000 \frac{\text{ N}}{\text{ roller}} \cdot f_1 \cdot f_2 \cdot f_3 \cdot f_4 \cdot f_5 \]

- Roller
- Case-hardened steel, hardened
- Insufficient lubrication, no dirt or rough operating conditions
- Chain velocity = 0,2 m/s
- Ambient temperature 10 - 25 °C

\[ f_1 : 1,0 \]
\[ f_2 : 1,0 \]
\[ f_3 : 0,4...0,6 \]
\[ f_4 : 1,0 \]
\[ f_5 : 1,0 \]

\[ \Rightarrow \text{Admissible roller load} = 3000 \frac{\text{ N}}{\text{ roller}} \cdot 1,0 \cdot 0,4 \cdot 0,4 \cdot 1,0 \cdot 0,4 = 1200 \frac{\text{ N}}{\text{ roller}} \]

\[ \Rightarrow \text{Existing roller load} = 1500 \frac{\text{ N}}{\text{ roller}} > 1200 \frac{\text{ N}}{\text{ roller}} \]

In dependence of the chain lubrication (factor f3), the admissible roller load may be exceeded. It is therefore more reasonable to select the next chain in size. \[ \Rightarrow \text{FVT 90} \]

d) Driving power required

\[ P = \frac{F_g \cdot v}{1000 \cdot \eta} \]
\[ F_g = 16400 \text{ N} \]
\[ \eta = 0,8 \]
\[ v = 0,2 \text{ m/s} \]

\[ P = \frac{16400 \cdot 0,2}{1000 \cdot 0,8} = 4,1 \text{ kW} \]