



The values given in the load table are based upon uniform, smooth operation,  $K_{H\beta}=1.0$  and reliable grease lubrication. Since, in practice, the applications are very diverse, it is important to consider the given conditions by using appropriate factors  $S_B$ ,  $K_A$ ,  $L_{KHB}$  and  $f_n$  (see below).

### Formulas for Determining the Tangential Force

$$a = \frac{v}{t_b} \quad [\text{m/s}^2]$$

$$F_u = \frac{m \cdot g + m \cdot a}{1000} \quad (\text{for lifting axle}) \quad [\text{kN}]$$

$$F_u = \frac{m \cdot g \cdot \mu + m \cdot a}{1000} \quad (\text{for driving axle}) \quad [\text{kN}]$$

$$F_{u \text{ perm.}} = \frac{F_{u \text{ Tab}}}{K_A \cdot S_B \cdot f_n \cdot L_{KHB}} \quad [\text{kN}]$$

Formula dimensions see page ZD-3

**The Condition  $F_u < F_{u \text{ perm.}}$  Must be Fulfilled.**

### Load Factor $K_A$

Drive	Type of load from the machines to be driven		
	Uniform	Medium Shocks	Heavy Shocks
Uniform	1.00	1.25	1.75
Light Shocks	1.25	1.50	2.00
Medium Shocks	1.50	1.75	2.25

### Safety Coefficient $S_B$

The safety coefficient should be allowed for according to experience ( $S_B = 1.1$  to  $1.4$ ).

### Life-Time Factor $f_n$

considering of the peripheral speed of the pinion and lubrication.

Lubrication	Continuous	Daily	Monthly
Peripheral Speed of Gearing			
m/sec    m/min			
0.5    30	0.85	0.95	
1.0    60	0.95	1.10	from
1.5    90	1.00	1.20	3
2.0    120	1.05	1.30	to
3.0    180	1.10	1.50	10
5.0    300	1.25	1.90	

### Linear Load Distribution Factor $L_{KHB}$

The linear load distribution factor considers the contact stress, while it describes unintegrated load distribution over the tooth width ( $L_{KHB} = \sqrt{K_{H\beta}}$ ).

$L_{KHB} = 1.1$  for counter bearing, e.g. Torque Supporter

$= 1.2$  for preloaded bearings on the output shaft e.g. ATLANTA HT, HP and E servo-worm gear unit, BG bevel-gear unit

$= 1.5$  for unpreloaded bearings on the output shaft e.g. ATLANTA B servo-worm gear unit





### Calculation Example

#### Values Given

⊗ Travelling Operation

Mass to be Moved  $m = 820$  kg  
 Speed  $v = 2$  m/s  
 Acceleration Time  $t_b = 1$  s  
 Acceleration Due to Gravity  $g = 9.81$  m/s<sup>2</sup>  
 Coefficient of Friction  $\mu = 0.1$   
 Load Factor  $K_A = 1.5$   
 Life-Time Factor  $f_n = 1.05$  (cont. lubrication)  
 Safety Coefficient  $S_B = 1.2$   
 Linear Load Distribution Factor  $L_{KH\beta} = 1.5$

#### Calculation Process

#### Results

$$a = \frac{v}{t_b} \quad a = \frac{2}{1} = 2 \text{ m/s}^2$$

$$F_u = \frac{m \cdot g \cdot \mu + m \cdot a}{1000}$$

$$F_u = \frac{820 \cdot 9.81 \cdot 0.1 + 820 \cdot 2}{1000} = 2.44 \text{ kN}$$

Assumed feed force: rack C45, ind. hardened, straight tooth, module 3, pinion 16MnCr5, case hardened, 20 teeth, page ZB-40 with  $F_{uTab} = 11.5$  kN

$$F_{u \text{ zul./per.}} = \frac{F_{uTab}}{K_A \cdot S_B \cdot f_n \cdot L_{KH\beta}} ;$$

$$F_{u \text{ zul./per.}} = \frac{11.5 \text{ kN}}{1.5 \cdot 1.2 \cdot 1.05 \cdot 1.5} = 4.05 \text{ kN}$$

#### Condition

$$F_{u \text{ zul./per.}} > F_u ; 4.05 \text{ kN} > 2.44 \text{ kN} \quad \Rightarrow \text{fulfilled}$$

Result: Rack 27 30 101 Page ZB-13  
 Pinion 24 35 220 Page ZB-23 case hardened

### Your Calculation

#### Values Given

⊗ Travelling Operation

Mass to be Moved  $m =$  \_\_\_\_\_ kg  
 Speed  $v =$  \_\_\_\_\_ m/s  
 Acceleration Time  $t_b =$  \_\_\_\_\_ s  
 Acceleration Due to Gravity  $g =$  9.81 m/s<sup>2</sup>  
 Coefficient of Friction  $\mu =$  \_\_\_\_\_  
 Load Factor  $K_A =$  \_\_\_\_\_  
 Life-Time Factor  $f_n =$  \_\_\_\_\_  
 Safety Coefficient  $S_B =$  \_\_\_\_\_  
 Linear Load Distribution Factor  $L_{KH\beta} =$  \_\_\_\_\_

#### Calculation Process

#### Results

$$a = \frac{v}{t_b} \quad a =$$
 \_\_\_\_\_ = \_\_\_\_\_ m/s<sup>2</sup>

$$F_u = \frac{m \cdot g \cdot \mu + m \cdot a}{1000} ; F_u =$$
 \_\_\_\_\_ = \_\_\_\_\_ kN

Permissible Feed Force  $F_{uTab}$

$$F_{u \text{ zul./per.}} = \frac{F_{uTab}}{K_A \cdot S_B \cdot f_n \cdot L_{KH\beta}} ;$$

$$F_{u \text{ zul./per.}} =$$
 \_\_\_\_\_ = \_\_\_\_\_ kN

#### Condition

$$F_{u \text{ zul./per.}} > F_u ;$$
 \_\_\_\_\_ kN > \_\_\_\_\_ kN  $\Rightarrow$  fulfilled





### Calculation Example

#### Values Given

⊗ Lifting Operation

Mass to be Moved  $m = 300 \text{ kg}$

Speed  $v = 1.08 \text{ m/s}$

Acceleration Time  $t_b = 0.7 \text{ s}$

Acceleration Due to Gravity  $g = 9.81 \text{ m/s}^2$

Load Factor  $K_A = 1.2$

Life-Time Factor  $f_n = 1.1$  (Cont. Lubrication)

Safety Coefficient  $S_B = 1.2$

Linear Load Distribution Factor  $L_{KH\beta} = 1.2$

#### Calculation Process

#### Results

$$a = \frac{v}{t_b} \quad a = \frac{1.08}{0.27} = 4 \text{ m/s}^2$$

$$F_u = \frac{m \cdot g + m \cdot a}{1000} \quad F_u = \frac{300 \cdot 9.81 + 300 \cdot 4}{1000} = 4.1 \text{ kN}$$

Assumed feed force: rack C45, ind. hardened, helical, module 2, pinion 16MnCr5, case hardened, 20 teeth, page ZA-31 with  $F_{uTab} = 12 \text{ kN}$

$$F_{u \text{ zul./per.}} = \frac{F_{uTab}}{K_A \cdot S_B \cdot f_n \cdot L_{KH\beta}} ; F_{u \text{ zul./per.}} = \frac{11.5 \text{ kN}}{1.2 \cdot 1.2 \cdot 1.1 \cdot 1.2} = 5.9 \text{ kN}$$

#### Condition

$$F_{u \text{ zul./per.}} > F_u ; 6.0 \text{ kN} > 4.1 \text{ kN} \Rightarrow \text{fulfilled}$$

Result: Rack 29 20 105 Page ZA-7

Pinion 24 29 520 Page ZA-24

### Your Calculation

#### Values Given

⊗ Lifting Operation

Mass to be Moved  $m = \underline{\hspace{2cm}} \text{ kg}$

Speed  $v = \underline{\hspace{2cm}} \text{ m/s}$

Acceleration Time  $t_b = \underline{\hspace{2cm}} \text{ s}$

Acceleration Due to Gravity  $g = \underline{9.81} \text{ m/s}^2$

Load Factor  $K_A = \underline{\hspace{2cm}}$

Life-Time Factor  $f_n = \underline{\hspace{2cm}}$

Safety Coefficient  $S_B = \underline{\hspace{2cm}}$

Linear Load Distribution Factor  $L_{KH\beta} = \underline{\hspace{2cm}}$

#### Calculation Process

#### Results

$$a = \frac{v}{t_b} \quad a = \underline{\hspace{2cm}} = \underline{\hspace{2cm}} \text{ m/s}^2$$

$$F_u = \frac{m \cdot g + m \cdot a}{1000} \quad F_{u \text{ erf./req.}} = \underline{\hspace{2cm}} = \underline{\hspace{2cm}} \text{ kN}$$

Permissible Feed Force  $F_{uTab}$

$$F_{u \text{ zul./per.}} = \frac{F_{uTab}}{K_A \cdot S_B \cdot f_n \cdot L_{KH\beta}} ; F_{u \text{ zul./per.}} = \underline{\hspace{2cm}} = \underline{\hspace{2cm}} \text{ kN}$$

#### Condition

$$F_{u \text{ zul./per.}} > F_u ; \underline{\hspace{2cm}} \text{ kN} > \underline{\hspace{2cm}} \text{ kN} \Rightarrow \text{fulfilled}$$

