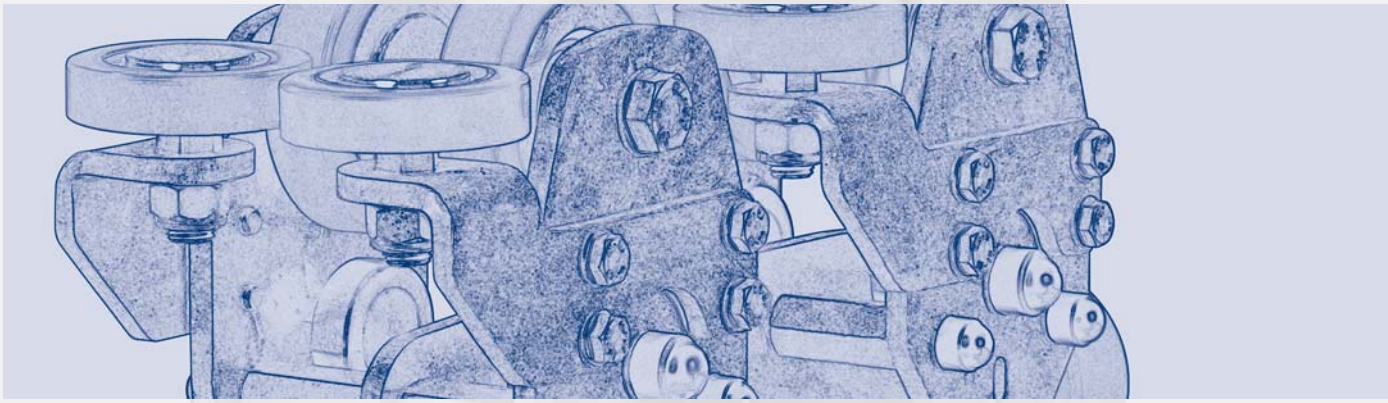
Engineering Guideline
Festoon Systems for I-beams



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Wampfler expertise in Heavy Duty Cable Trolleys

Solutions for a moving world: Whenever objects or people are in motion, Wampfler can provide customized solutions for flexible energy, data and media transmission.

Wampfler stands out for their many years of experience and wide know-how in the development and manufacturing of festoon systems.

These trolleys carry flat and round cables for the transmission of electrical energy and data as well as hoses for the transmission of liquids, air or gases.

Wampfler festoon systems are used in various applications all over the world, among others in steel works, ports, galvanizing and composting plants.

This engineering guideline will assist you with the layout of non-motorized systems. It provides the basic data for the layout and calculation of festoon systems.

Structure and Content

Typical Components of a Cable Trolley for I-beams

■ Main roller (HTR)

Function: allow movement of cable trolley, carry the cable trolley weight as well as cable weight

Design: cylindrical or flanged roller

Material: steel or plastic bandage

Specific feature: precision ball bearing lubricated for lifetime with additional sealing disk (2RS1)

■ Anti-lift roller (GDR)

Function: protection against lifting, increased protection against tilting

Design: cylindrical roller

Material: steel bandage

Specific feature: precision ball bearing lubricated for lifetime with additional sealing disk (2RS1)

■ Horizontal guide roller (HFR)

Function: precise guidance of the cable trolley

Design: cylindrical roller

Material: steel or plastic bandage

Specific feature: precision ball bearing lubricated for lifetime with additional sealing disk (2RS1)

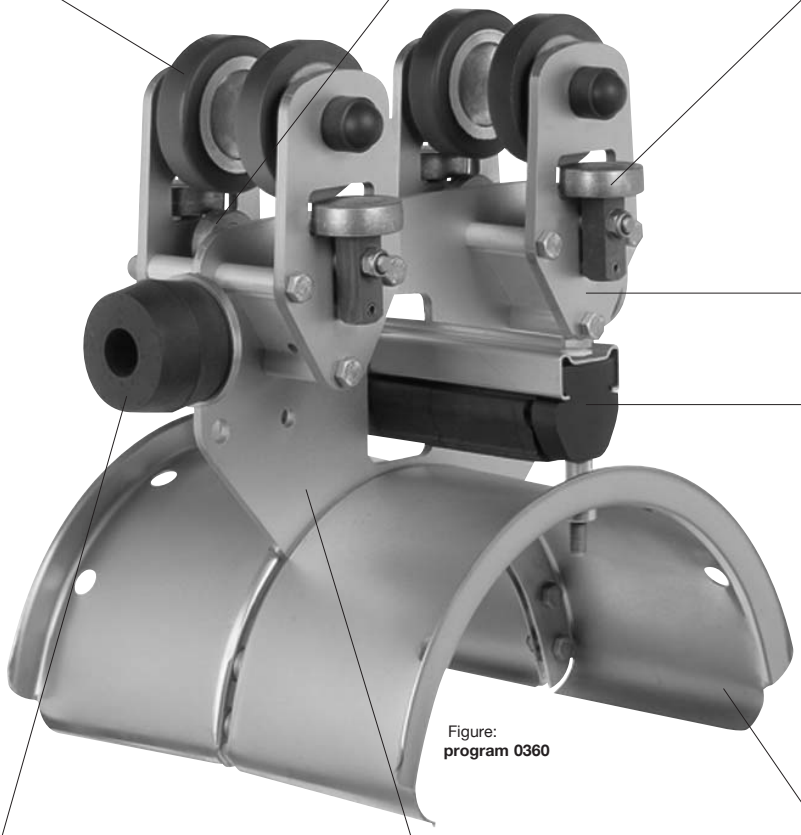


Figure:
program 0360

■ Side shield

Function: arrangement of the rollers in a minimum space

Material: steel, hot dipped galvanized

Specific feature: three-point fixation for optimum distribution of forces

■ Clamping bar

Function: fixation of the cables on the cable support

Material: rubber
steel, hot dipped galvanized

Specific feature: group clamping segmented for the clamping of different cable diameters

■ Large-volume buffer

Function: minimize the impact load of the cable trolley

Material: rubber / polyurethane

Specific feature: optimized characteristic

■ Center plate

Function: attachment of cable supports, buffers and chassis

Material: steel, hot dipped galvanized

Specific feature: for maximum stability

■ Cable support

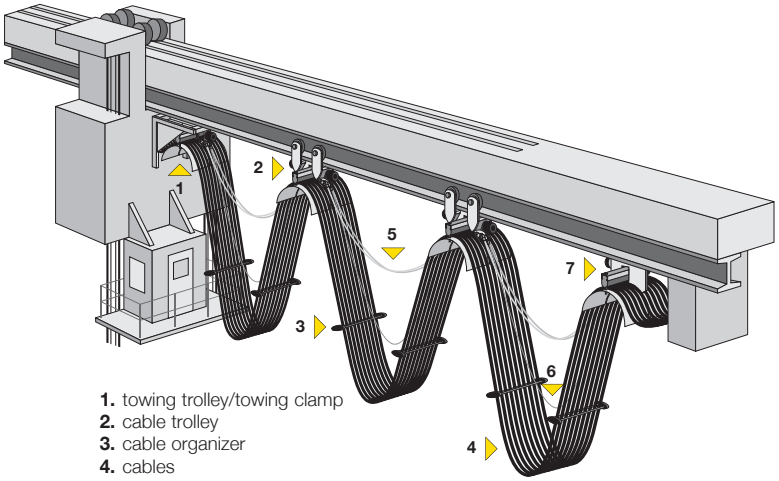
Function: support of cables according to minimum bending radii

Design: one-piece (max. stability and bending strength)

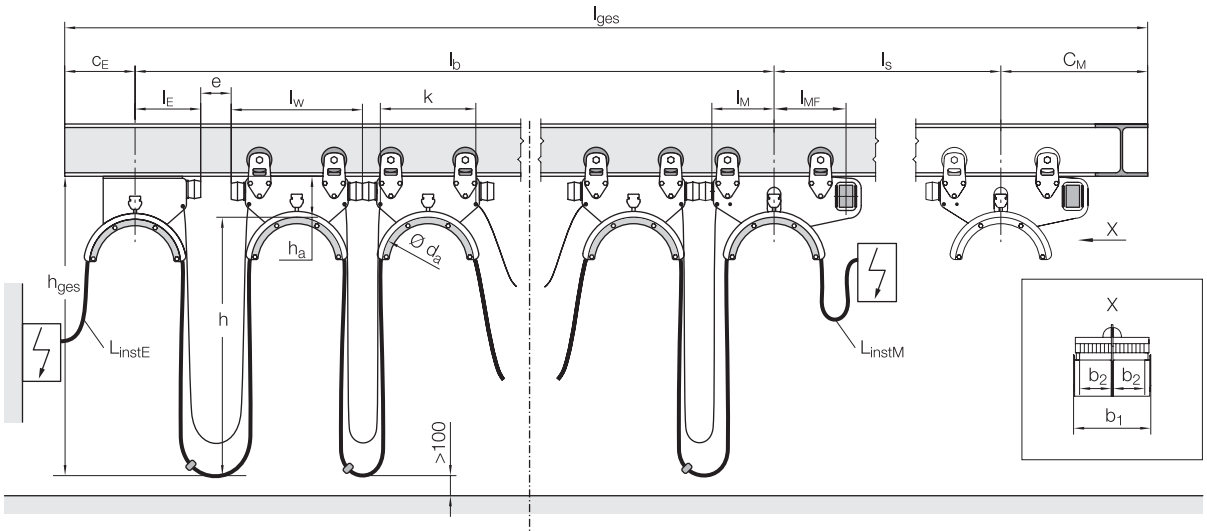
Material: steel, hot dipped galvanized

Specific feature: riveted nut for easy assembly

System illustration

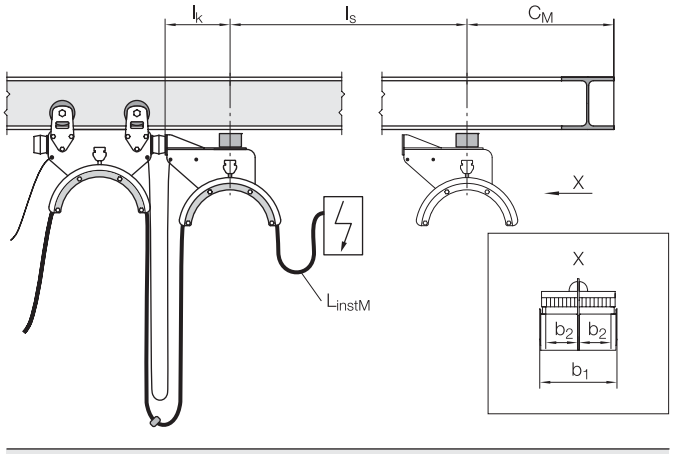


1. towing trolley/towing clamp
2. cable trolley
3. cable organizer
4. cables
5. damping device
6. towing rope
7. end clamp



System with towing trolley

b_1	cable trolley width
b_2	max. permissible clamping width
C_E	beam clearance end clamp side
C_M	beam clearance towing side
d_a	support diameter
e	free space within storage distance
h	cable loop depth
h_a	cable trolley height from lower edge of beam to upper edge of cable support
h_{ges}	cable loop depth from lower edge of beam to loop bottom
k	drill hole distance for towing rope fixation
l_b	storage distance including free space (e)
l_E	end clamp length
l_{ges}	track beam length
L_{instE}	installation length end clamp side
L_{instM}	installation length towing side
l_K	towing clamp length
l_M	towing trolley length
l_{MF}	distance from middle of towing trolley to middle of towing window
l_s	active travel (e.g. main trolley or crane travel)
l_w	cable trolley length



System with towing clamp

Layout Step 1
Cable selection and arrangement

The first step to layout a festoon system is

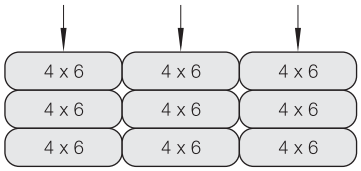
- Preparation of a list of required cables and their cross sections.
- Selection of the appropriate type of cable (flat or round cable) and of the required quality for the respective application (PVC or Neoprene cable) from our cable program

Prior to making a selection of the required cable trolleys it is important to follow the details listed on the right for the layout of the cable package:

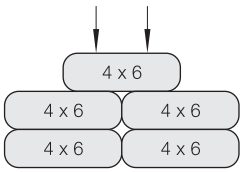
Arrangement of flat cables on the cable support

The flat cable package must be piled in such a way that all cables are clamped compact on the cable supports and cannot slip.

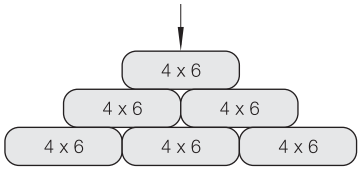
The cable package height in relation to the width shall not be too high, since otherwise the cable package will be unstable and individual, especially smaller cables, will not be clamped sufficient any more.



very good - 100 % clamping



good - 50 % clamping



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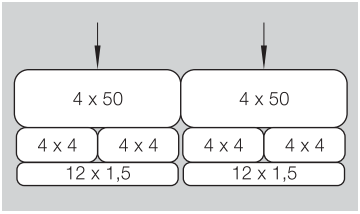
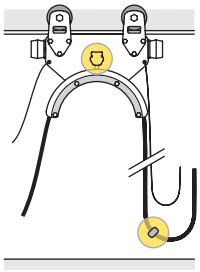
The thicker energy cables (e.g. 4x50) shall be placed on top of the cable package. This will assure good heat dissipation and proper clamping of the smaller cables.



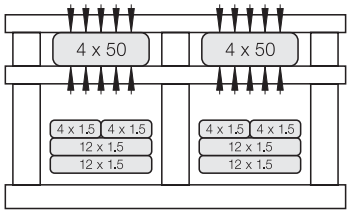
Occurring tractive forces during the movements can partly be absorbed by these cables.

Whenever possible wider cables should be used instead of multiple smaller cables , e.g.:
1 piece 12 x 1.5 instead of 3 pieces 4 x 1.5



Arrangement of flat cables within the cable organizer

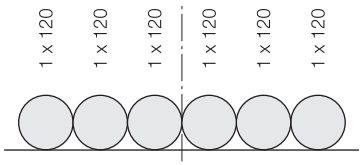
Cable organizers are used to hold together the cable package in the cable loop. The thicker energy cables (e.g. 4x50) are clamped in the upper window, all the other cables are guided in the lower window and can move freely. The arrangement of the cable package must be suitable to fit into the respective clamping window.



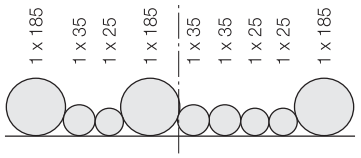
Clamping of screened cables shall be avoided.

Arrangement of round cables on the cable support

The diameters of the round cables shall not vary too much in order to allow proper clamping on the cable supports.



very good



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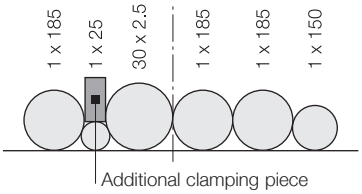
If deviations in diameters of adjacent cables are more than 15 mm use additional clamping pieces for a proper clamping.

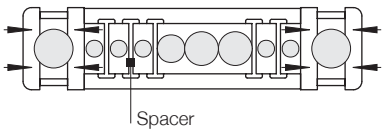


Arrangement of round cables within the cable organizer

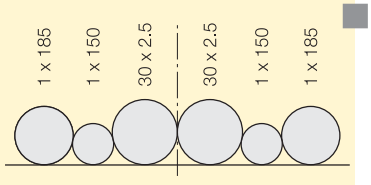
Cable organizers are used to hold together the cable package in the cable loop. The outer cables are clamped, all the other cables are guided in the inner window and can move freely.

Unscreened energy cables with larger copper cross sections should be favored for the outer cables (e.g. 1x120 or 4x25).

Additional spacers can be installed in the cable organizer to avoid overlapping of cables in case of larger differences in diameter.



Applies for all cables:
Observe balance of torque.



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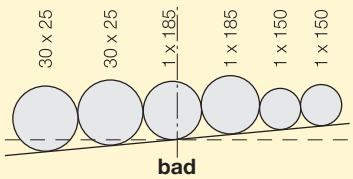

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Layout Step 2
Selection of the cable trolley program

1 ■ Determination of the cable trolley load (F_{LW})

The second step for the calculation starts with the approximate determination of the cable trolley load (F_{LW}).

$$F_{LW} = 2 \times h \times G_L$$

F_{LW} = cable trolley load in kg
h = cable loop depth in m
G_L = cable package weight in kg/m

2 ■ Selection of the main roller size

With the determined cable trolley load F_{LW} the required main roller size can be defined from the following table. First of all the material of the main roller has to be selected:

Specification	Material
standard	rollers made of hardened **steel**
for low noise emission and low beam wear	rollers with plastic bandages made of a Polyurethane-Elastomer ***Vulkollan®***
for tropical or subtropical climate	rollers with hydrolysis resistant plastic bandages, e.g. ***Adiprene®***

Main rollers with steel bandages	**Travel speed v in m/min**							
	up to **63**	**80**	**100**	**125**	**160**	**200**	**250**	**300**
Ø in mm	Permissible cable trolley load **F_{LW}** in kg							
40	40	36	32					
50	75	68	60	51				
63	125	110	95	85	75			
80	220	190	162	142	125	110		
100	355	305	265	230	200	185	160	
125	590	550	500	450	410	380	350	310
160	1150	1090	1050	1015	990	970	950	925

Operating time : ~16h / day
Ambient temperature : -30°C ... +80 °C

***Reduction factors**
for main rollers with ***Vulkollan®*** or ***Adiprene®*** **bandages**

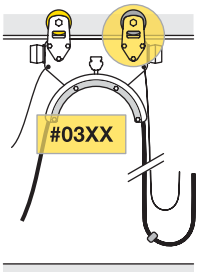
In case of higher ambient temperatures, depending on the trolley load, you may have to choose a higher roller diameter for ***Vulkollan®*** and ***Adiprene®*** rollers, since the permissible cable trolley load **F_{LW}** is, depending on the ambient temperature, reduced by the following factors:

Ambient temperature	Reduction factor
40°C ... 50°C	**0.90**
50°C ... 60°C	**0.80**
60°C ... 70°C	**0.65**

Main rollers with *Vulkollan®* bandages	**Travel speed v in m/min**							
	up to **63**	**80**	**100**	**125**	**160**	**200**	**250**	**300**
Ø in mm	Permissible cable trolley load **F_{LW}** in kg							
40	32	29	26					
50	60	53	47	42				
63	110	98	90	80	70			
80	195	170	155	135	115	100		
100	325	280	250	215	185	165	150	
112	430	395	360	330	305	275	250	210
125	540	515	460	410	380	350	320	290
160	1020	975	940	915	890	870	850	825

Main rollers with *Adiprene®* bandages	**$F_{LW} = F_{LW\ Vulkollan®} \times 0{,}8$**

Operating time : ~16h / day
Ambient temperature : -30°C ... +40 °C



3 ■ Determination of the cable trolley program

With the size of the main roller
- the suitable cable trolley **program** and
- the **possible chassis types for this program**

can be defined from the following table:

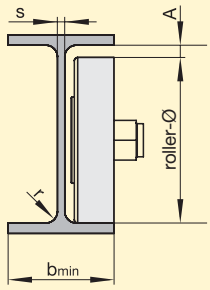
Main rollers Ø in mm	v_{max} in m/min	type of cable	program	Possible chassis types	
				track beam	
				parallel flange	tapered flange
40	50	flat/round	**0314**	S	S
40	75	flat	**0315**	-	H
40	100	flat/round	**0320**	S, SG	H, HG, S, SG
50	120	flat/round	**0325**	S, SG	H, HG, S, SG
63	150	flat/round	**0330**	S, SG	H, HG, S, SG
50/63/80/100	160	flat	**0350**	HF, HFG, S, SG	H, HG, HF, HFG, S, SG
50/63/80/100/112/125	160	round	**0360**	HF, HFG, S, SG	H, HG, HF, HFG, S, SG
100/112/125	180	round	**0364**	HFG	HFG
112/125	300	round	**0365**	HMG, HMP	HMG, HMP
125	210	flat	**0370**	HMG, HMP	HMG, HMP
125/160	300	round	**0375**	HMG, HMP	HMG, HMP
125/160	300	round	**0380**	HMG, HMP	-
160	300	round	**0385**	HMG, HMP	-

Chassis type overview see next page >>>

■■ motorized systems are used
for the fields highlighted in gray
– Please contact us –

■ Minimum beam dimension

The following beam dimensions are necessary due to the installation space required by the chassis in the beam:

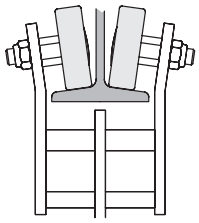


Air gap A (between main roller and beam flange) **= min. 10 mm**

Minimum beam width b_{min} in mm $= 2 \times \left(\frac{\text{roller-Ø}}{4} + r \right) + s + 10$

4 ■ Selection of the chassis type

Type **H**



- For simple applications with low lateral forces
- Not suitable for towing trolley

Chassis with cylindrical main rollers

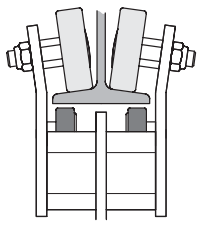
guidance of the chassis at the radius of the beam web

guidance of the chassis	simple	optimal
protection against tilting	low	high
protection against lifting	low	high
wear of beam/rollers	high	low

Standard application data

I-beam	tapered flange
beam width max.	100 mm
travel speed	< 120 m/min
main roller material	steel, plastic

Type **HG**



- For simple applications with low to medium lateral forces and tilting torques
- Suitable for towing trolleys

Chassis with cylindrical main rollers and anti-lift rollers

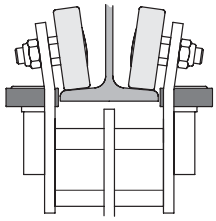
guidance of the chassis at the radius of the beam web

guidance of the chassis	simple	optimal
protection against tilting	low	high
protection against lifting	low	high
wear of beam/rollers	high	low

Standard application data

I-beam	tapered flange
beam width max.	100 mm
travel speed	< 120 m/min
main roller material	steel, plastic

Type **HF**



- For applications with low to medium lateral forces
- Not suitable for towing trolley

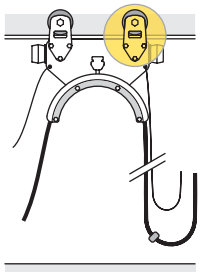
Chassis with cylindrical main rollers and horizontal guide rollers

guidance of the chassis at the beam flange

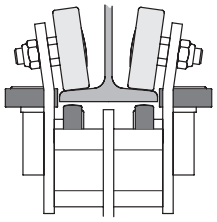
guidance of the chassis	simple	optimal
protection against tilting	low	high
protection against lifting	low	high
wear of beam/rollers	high	low

Standard application data

I-beam	parallel/tapered flange
beam width max.	140 mm
travel speed	< 150 m/min
main roller material	steel, plastic



Type
HFG



- For applications with medium to high lateral forces and tilting torques
- Suitable for towing trolleys

Chassis with cylindrical main rollers with horizontal guide rollers and anti-lift rollers

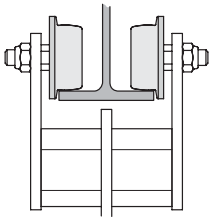
guidance of the chassis at the beam flange

guidance of the chassis	simple		optimal
protection against tilting	low		high
protection against lifting	low		high
wear of beam/rollers	high		low

Standard application data

I-beam	parallel/tapered flange
beam width max.	140 mm
travel speed	< 180 m/min
main roller material	steel, plastic

Type
S



- For applications with low to medium lateral forces
- Not suitable for towing trolleys

Chassis with flanged main rollers

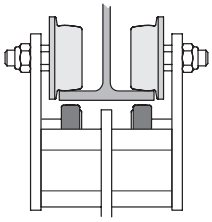
guidance of the chassis at the beam flange

guidance of the chassis	simple		optimal
protection against tilting	low		high
protection against lifting	low		high
wear of beam/rollers	high		low

Standard application data

I-beam	parallel/tapered flange
beam width max.	140 mm
travel speed	< 80 m/min
main roller material	steel

Type
SG



- For applications with low to medium lateral forces and tilting torques
- Suitable for towing trolleys

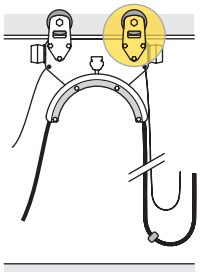
Chassis with flanged main rollers and anti-lift rollers

guidance of the chassis at the beam flange

guidance of the chassis	simple		optimal
protection against tilting	low		high
protection against lifting	low		high
wear of beam/rollers	high		low

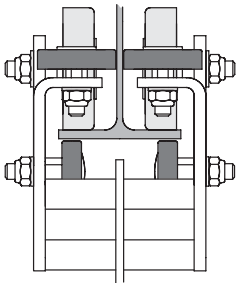
Standard application data

I-beam	parallel/tapered flange
beam width max.	140 mm
travel speed	< 80 m/min
main roller material	steel



4 ■ Selection of the chassis type

Type
HMG



- For applications under very difficult conditions (e.g. STS container cranes)
- Suitable for towing trolleys

Chassis with cylindrical main rollers with horizontal guide rollers at the beam center web and anti-lift rollers

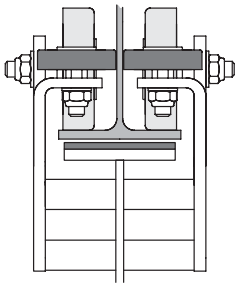
guidance of the chassis at the beam center web

guidance of the chassis	simple	■■■■■	optimal
protection against tilting	low	■■■■■	high
protection against lifting	low	■■■■□	high
wear of beam/rollers	high	■■■■■	low

Standard application data

I-beam	parallel/tapered flange
beam width max.	200 mm
travel speed	< 300 m/min
main roller material	plastic

Type
HMP



- For applications with motorized cable trolleys and heavy cable packages
- Suitable for towing trolleys

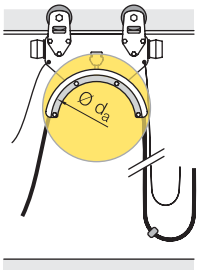
Chassis with cylindrical main rollers with horizontal guide rollers at the beam center web and anti-lift plate

guidance of the chassis at the beam center web

guidance of the chassis	simple	■■■■■	optimal
protection against tilting	low	■■■■■	high
protection against lifting	low	■■■■□	high
wear of beam/rollers	high	■■■■■	low

Standard application data

I-beam	parallel/tapered flange
beam width max.	200 mm
travel speed	< 300 m/min
main roller material	plastic



5 ■ Determination of the cable support diameter

For the determination of the cable trolley size the required cable support diameter **d_a** is to choose. This must correspond with the cables being installed.

The smallest permissible cable support diameter **d_a** is determined on the basis of the largest cables:

	thickness of flat cable **$S_{FL} \leq 12{,}5$ mm**	thickness of flat cable **$S_{FL} \geq 12{,}5$ mm**	outer diameter of round cable **d_{RL} = outer diameter**
min support-Ø d_a in mm	**8 x S_{FL}**	**10 x S_{FL}**	**10 x d_{RL}**

Example of calculation
flat cable:

The thickness of the largest flat cable is 13 mm

Accordingly the minimum support diameter is:
d_a = 10 x 13 mm = 130 mm

Example of calculation
round cable:

The outer diameter of the largest round cable is 20 mm

Accordingly the minimum support diameter is:
d_a = 10 x 20 mm = 200 mm

Layout Step 3
Calculation of the system

1 ■ Determination of the number of loops

For the determination of the number of loops it is required to define the cable loop depth **h** and choose the additional cable length factor **f** from the table below.

$$n = \frac{f \times (l_s + e)}{2 \times h + 1{,}25 \times d_a - f \times l_W}$$

n = number of loops
l_s = active travel in m
f = additional cable length factor (see table below)
h = cable loop depth in m
d_a = support diameter in m
l_W = cable trolley length in m
e = free space in storage distance (recommendation ≥ 0.5 m)

n determines the number of required cable trolleys:
Number of cable trolleys = n-1

2 ■ Determination of the required storage distance from middle of end clamp to middle of towing trolley

For further calculations round up the number of loops.

$$l_b = (n-1) \times l_W + l_E + l_M + e$$

l_b = storage distance from middle of end clamp to middle of towing trolley in m
n = number of loops
l_W = length of cable trolley in m
l_E = length of end clamp in m
l_M = length of towing trolley/towing clamp in m
e = free space in storage distance (recommendation ≥ 0.5 m)

3 ■ Determination of the cable system length from middle of end clamp to middle of towing trolley and of the order length of the cable

$$L_{Syst} = f \times (l_s + l_b)$$

$$L_{Best} = L_{Syst} + L_{instE} + L_{instM}$$

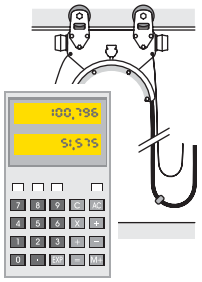
L_{Syst} = required cable system length from middle of end clamp to middle of towing trolley/towing clamp in m
f = additional cable length factor
l_s = active travel in m
l_b = storage distance in m
L_{instE} = installation length end clamp side in m
L_{instM} = installation length towing side in m
L_{Best} = cable order length inclusive installation length in m

■ Determination of the additional cable length factor f

additional length factor f	cable loop depth h in m					
travel speed v_{max} in m/min	< 0,8	0,8 - 1,2	1,3 - 2,0	2,1 - 3,2	3,3 - 5,0	5,1 - 8,0
32	**1,10**	**1,10**	**1,10**	**1,10**	**1,10**	**1,10**
33 - 40	**1,15**	**1,10**	**1,10**	**1,10**	**1,10**	**1,10**
41 - 50	**1,20**	**1,15**	**1,10**	**1,10**	**1,10**	**1,10**
51 - 63	**1,25**	**1,20**	**1,15**	**1,10**	**1,10**	**1,10**
64 - 80		**1,25**	**1,20**	**1,15**	**1,10**	**1,10**
81 - 100			**1,25**	**1,20**	**1,15**	**1,10**
101 - 125				**1,25**	**1,20**	**1,15**
126 - 160				**1,25**	**1,25**	**1,20**
161 - 200				**1,25**	**1,25**	**1,25**
201 - 250				**1,25**	**1,25**	**1,25**
251 - 300				**1,25**	**1,25**	**1,25**

■■ For the fields highlighted in yellow we recommend the use of damping devices or motorized systems to stabilize the cable loops.
– Please contact us –

■■ For the fields highlighted in gray motorized systems will be used.
– Please contact us –



4 ■ Determination of the actual cable loop

$$h = \frac{L_{Syst}}{2xn} - (0{,}63 \times d_A)$$

h = cable loop depth
L_{Syst} = required cable system length measured from middle of end clamp to middle of towing trolley or towing clamp in m
d_a = support diameter in m
n = number of loops

5 ■ Dimensioning of the towing rope lengths

$$L_{Zug} = 0{,}95 \times \frac{L_{Syst}}{n} - (k+0{,}084)$$

For travel speeds higher than 50 m/min we recommend the use of towing ropes.

Please take the dimension **k** for the towing rope fixation from the respective cable trolley program.

6 ■ Selection of the damping device

$$L_{Gum} = \frac{L_{Zug}}{1{,}5}$$

L_{Gum} = shock cord length in m
L_{Zug} = towing rope length in m

The selection of the correct damping device (quantity and diameter of the shock cords) depends on various factors of the respective application.

– Please contact us –

Symbols and units

b_1	mm	cable trolley width
b_2	mm	max. permissible clamping width
c_E	m, mm	beam clearance end clamp side
c_M	m, mm	beam clearance towing side
d_a	mm	support diameter
d_{RL}	mm	outer diameter round cable
e	m, mm	free space within the storage distance
f		additional cable factor length
F_{LW}	kg	cable trolley load
G_L	kg/m	cable package weight
h	m, mm	cable loop depth
h_a	m, mm	cable trolley height from lower edge of beam to upper edge of cable support
h_{ges}	m	cable loop depth from lower edge of beam to loop bottom
k	m, mm	drill hole distance for towing rope fixation
l_b	m	cable trolley storage including free space (e)
L_{Best}	m	cable order length
l_E	m, mm	end clamp length
l_{ges}	m	track beam length
L_{Gum}	m	shock cord length
L_{instE}	m	installation length end clamp side
L_{instM}	m	installation length towing side
l_K	m, mm	towing clamp length
l_M	m, mm	towing trolley length
l_{MF}	m, mm	distance from middle of towing trolley to middle of towing window
l_s	m	active travel (e.g. main trolley or crane travel)
L_{Syst}	m	cable system length
l_W	m, mm	cable trolley length
L_{Zug}	m	towing rope length
n		number of loops
s	mm	clamping height at the cable trolley
s_{FL}	mm	thickness of flat cable
v	m/s, m/min	travel speed

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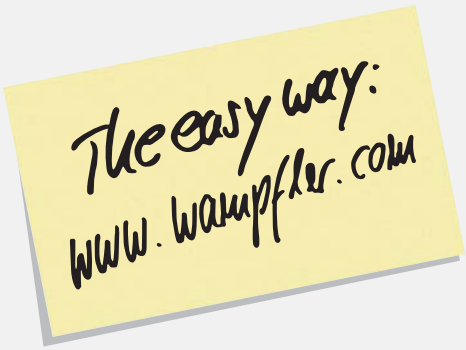

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