TECHNICAL GUIDE FOR END CARRIAGES

SWF Krantechnik GmbH
Postbox 310410
68264 Mannheim
Germany

Boehringer Straße 4
68307 Mannheim
Germany

tel +49(0)621 789-900
fax +49(0)621 789 90-100
Info@swfkrantechnik.com
www.swfkrantechnik.com

Read the instructions supplied with the product before installation and commissioning.

Keep the instructions in a safe place for future reference.

Table of content

1 GENERAL

The ES and ET end carriages are top running end carriages for cranes. The type codes for 2-wheel end carriages are ES11, ES14, ET09, ET11, ET14, ET20, ET25, ET32 and ET50, 4-wheel end carriages are ET20B, ET25B, ET32B and ET50B. The rail wheel sizes are D90, D110, D140, D200, D250, D320 and D500 mm.

The maximum wheel loads of the rail wheels are determined by the steel structure, the permissible surface pressure of the rail wheel, the maximum bearing capacity and the service life of the bearings.

The rail wheels of the end carriage can not be re-aligned.

When selecting the correct end carriage, following checks should be made:

- dynamic wheel load not to exceed allowed value
- steel structure not to exceed allowed value
- end carriage and main girder joint not to exceed allowed value

The joint between the end carriage and the main girder is done as a bolt joint.

In following document single girder crane is abbreviated as SG and double girder crane as DG.

2 CONSTRUCTION

FEM1.001-1987/Revised edition 1998 is used as a basic standard in the dimensioning of the end carriages. End carriages are designed for use in crane group A5. The calculation group for machinery has been M4 and for component E4. In higher classifications cases consult with product specialist.

2.1 Steel structure

The steel structure of the end carriage is designed to withstand of the dynamic wheel loads, which are shown in Appendix A.

The ES and ET09…20 end carriages are made of rectangular hollow section.

The ET25…50 end carriages are a welded box type construction. The positions of the diaphragms are standardized with different joint plates.

The wheel boxes of the end carriage and the fixing spots of the joint plate, as well as the bogie joint beam are machined with one fixing after assembly welding, in order to make the alignment of the wheels accurate.

The end carriages are equipped with derailment supports.

The material of the steel structure is S355J2G3 / EN10025. (Fe52D yield strength = min. 355 N/mm^2)

2.2 Rail wheels

The rail wheel diameters are D90, D110, D140, D200, D250, D320 and D500 mm and they are available with or without flanges.

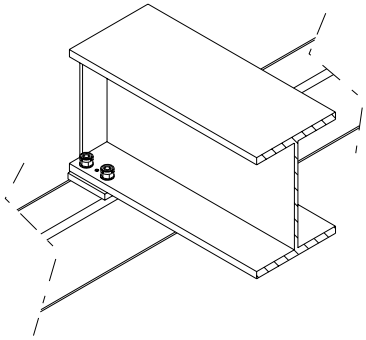
The material of the rail wheel is GJS700-2 / EN-JS1070 (ductile iron).

The driving shafts and connections are individual for each end carriage. These shafts must be stated in the order of travelling unit.

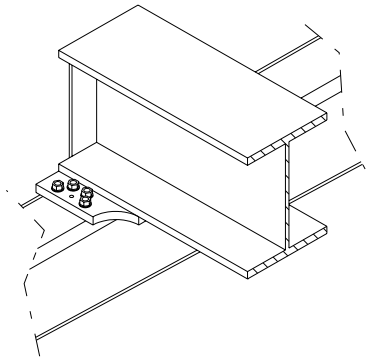
2.3 End Carriage and Main Girder connection

Main girder connection to the joint plate has to be calculated case by case and joint plate itself needs to be sized accordingly (max values for joint plates have to be checked). Here under you can see few examples about joints.

2.3.1 Top connection, C - top connection (profile girder).



Example about C joint



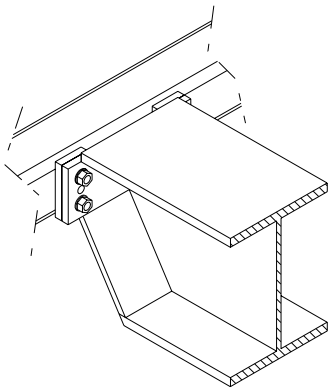
Example about L joint

Welded plate on end carriage, the main girder is locked with bolts.

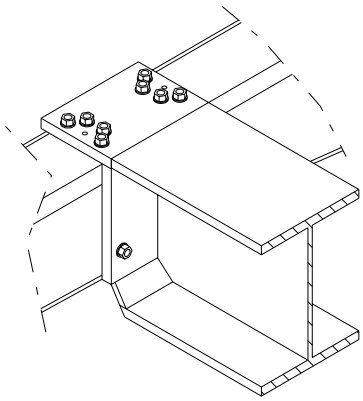
2.3.2 Top connection, P/L/K - top connection (profile or box girder).

The main girder is welded directly on the joint plate and the joint plate is locked on the end carriage with bolts.
On delivery the bolts are just pre-assembled, final tightening have to be done when assembled on crane. More information about joint plates from data page drawings (DP-EC14-C1-A_, DP-EC14-P4-A_, DP-EC20-L3-A_, DP-EC50-K5-A_).

2.3.3 Side connection, R / S- connection (profile or box girder)



Example about ES joint



Example about R joint

The main girder is welded to joint plate, joint plate is locked to the end carriage with bolts.

2.3.4 Side connection, ES- connection (profile or box girder)

The main girder is welded to joint plate, joint plate is locked to the end carriage with bolts and pins.
On delivery the bolts are just pre-assembled, final tightening have to be done when assembled on crane. More information about joint plates from data page drawings (DP-ES11-A_, DP-ES14-A_, DP-EC20-R3-A_, DP-EC50-S7-A_).

2.3.5 Maximum moments for joint plates

In some loading cases the max moment of joint plate may be the limiting factor. The allowed moments are collected in following table. The moment of joint plate can be checked with formulas:

Case I My =(0,125*Pdyn/1,15*SS)*Ngir
Case III My =(0,3*Pdyn/1,15*SS)*Ngir

Where
Pdyn = max dynamic wheel load
SS = end carriage wheel base
Ngir = number of main girders.

Calculated max moments for joint plates:

Joint plate	Profile/box	My (I) max	My (III) max	Pstat max	Bolt
C1, C2	yes/no	20 kNm	20 kNm	as Pdyn max	2
C4	yes/no	26 kNm	26 kNm	as Pdyn max	2
P3	yes/yes	31 kNm	31 kNm	as Pdyn max	1
P4	yes/yes	35 kNm	35 kNm	as Pdyn max	1
P6	yes/yes	49 kNm	49 kNm	as Pdyn max	1
L3	yes/yes	66 kNm	66 kNm	as Pdyn max	1
L4	yes/yes	84 kNm	84 kNm	as Pdyn max	1
L5	yes/yes	100 kNm	100 kNm	as Pdyn max	1
K4	yes/yes	124 kNm	124 kNm	as Pdyn max	1
K5	yes/yes	148 kNm	148 kNm	as Pdyn max	1
K7	yes/yes	194 kNm	194 kNm	as Pdyn max	1
R3(profile)	yes/no	15 kNm	36 kNm	90 kN	1+2
R3(box)	yes*/yes	28 kNm	69 kNm	as Pdyn max	1+2
R4	yes*/yes	34 kNm	82 kNm	as Pdyn max	1+2
R5	yes*/yes	34 kNm	82 kNm	as Pdyn max	1+2
S4	yes*/yes	57 kNm	138 kNm	as Pdyn max	1+3
S5	yes*/yes	78 kNm	187 kNm	as Pdyn max	1+3
S6	yes*/yes	106 kNm	254 kNm	as Pdyn max	1+3
S7	yes*/yes	162 kNm	390 kNm	as Pdyn max	1+3
ES11(JPL=220)	yes/no	5,85 kNm	14,14 kNm	26 kN	2
ES14(JPL=220)	yes/no	11,8 kNm	28,3 kNm	43 kN	2
ES14(JPL=300)	no/yes	11,8 kNm	28,3 kNm	43 kN	2
ES14(JPL=410)	no/yes	15,8 kNm	38 kNm	47 kN	2

*=allowed to use profile girder with box values when the end of girder is boxed.

Bolt types and tightening torques:
- DIN931-M16x__-8.8-A3G, 300Nm
- DIN931-M20x__-8.8-A3G, 390Nm
- DIN931-M20x__-10.9-A3G, 580Nm

2.3.6 Joint plate assembly information

If the joint plate has been separate from end carriage put it back with following instruction.
- Hit guiding pins thru plate and end carriage (D10 holes on top, or D20 in side with ES)
- Fix bolts on top of joint plate or in side with ES (check the tightening torque)
- Take out the gap between side plate and end carriage with tightening the hex hole sleeve (with R and S plates).
- Fix bolts on side (thru the hex hole sleeve, with R and S plates) of joint plate (check the tightening torque)

2.4 Buffers

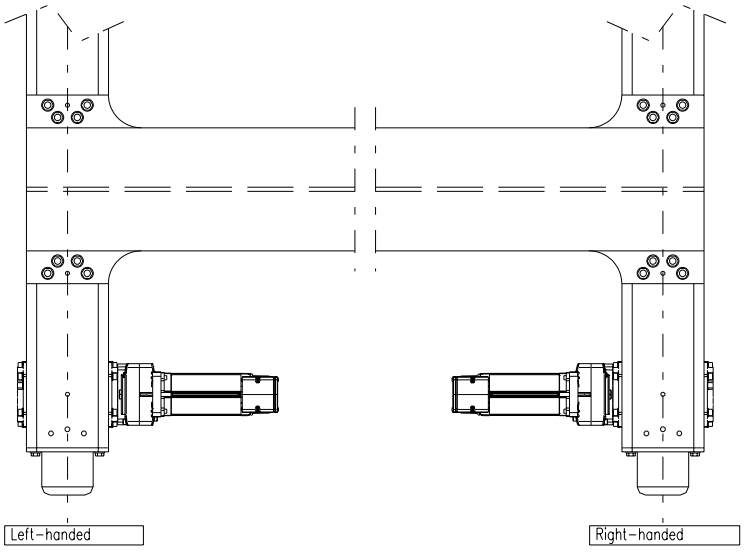
The buffers are fixed to both ends of the end carriage by bolt connection, one bolt/buffer. The following buffer alternatives are available; rubber- and polyurethane buffers.
The buffers are selected case by case and the buffer type shall be included in the end carriage ordering code. The buffers suitability to the end carriages has to be checked separately (e.g. oversize buffers) from data page drawings.

CODE	Diam/mm	Length/mm	Material
A	63	53	Rubber
B	80	68	Rubber
C	100	85	Rubber
D	125	105	Rubber
E	100	150	Polyurethane
F	125	190	Polyurethane
H	160	160	Polyurethane
I	200	200	Polyurethane
M	125	125	Polyurethane
P	160	240	Polyurethane
S	200	300	Polyurethane

2.5 Travelling Machineries

ES / ET end carriages are designed to use with GES drives. The travelling machineries must always be ordered separately and are as standard located.

2.5.1 Standard Location of travelling machineries



2.5.2 Suitable travelling machineries

Gear	End Carriage
GES3	ES11, ES14, ET09, ET11, ET14, ET20
GES4	ET20, ET25, ET32
GES5	ET25, ET32, ET50

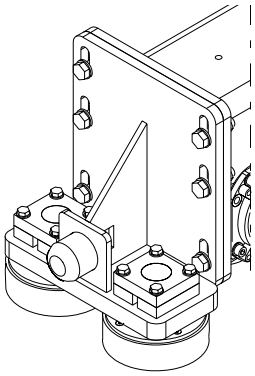
For closer information see GES data pages.

2.6 Additional features

Additional features can be ordered with end carriages. When ordered, the last letter in code (N-when standard) have to be E, and needed additional information have to be told.
Example:

ET50-2780-K50500C0000-E
E=guide roller in right handed end carriage, rail A65

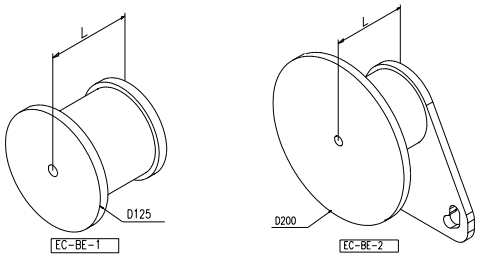
2.6.1 Guide rollers



Standard guide roller boxes are designed separately for each wheel size and they can take the same horizontal forces as end carriages. The guide rollers are fixed to the ends of the end carriages with bolt joint (ET20) or welding (ET25,-32,-50). Re-alignment can be done by turning the eccentric shafts, when the rollers can be adjusted in the radial direction ± 5mm. More information from data page drawings (DP-EC-GR-A_).

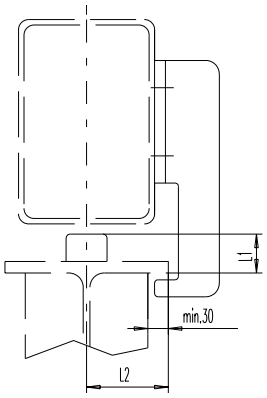
Guide rollers are available when needed (with ET20,-25,-32,-50). The guide rollers can be used when the rail is fixed by welding or with rail clamps, but the space between guide roller and clamp/welding seam must be checked case by case. The guide rollers must be mentioned separately in the end carriage order (special properties). NOTE! Used rail width must be mentioned. It have to be told also if the guide roller is fixed to right or left handed end carriage.

2.6.2 Buffer extension



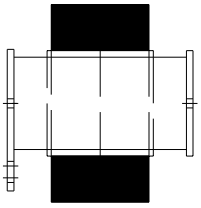
ES/ET end carriages can be equipped with buffer extension. EC-BE-1 fits with all ES/ET end carriages and can be used with smaller buffers. EC-BE-2 can be used with ET20…ET50 with bigger buffers. Buffer extension can be ordered separately. NOTE! When ordered; dimension L (wanted length) must be mentioned. More information from data page drawings (DP-EC-BE-A_).

2.6.3 Derailment catches



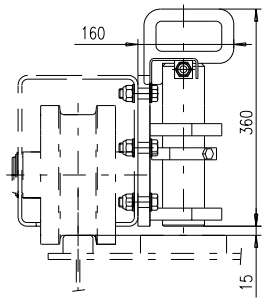
ET end carriages can be equipped with derailment catches. The derailment catches must be mentioned separately in the end carriage order (special properties). NOTE! Dimensions L1 and L2 must be mentioned. Location of the catches must be mentioned (right or left handed end carriage or both, driving unit side or opposite side of end carriage, dimension from driving wheel). More information from data page drawing (DP-EC-DC-A_).

2.6.4 Rail sweeps



ES/ET end carriages can be equipped with rail sweeps. Sweeps can be ordered separately, but it have to be told to which end carriage it will be fixed. Sweeper is working with gravity, type wooden block, which is easy to replace when it wears out. NOTE! Rail sweeps will add dimension from wheel to the end, as buffer extension. More information from data page drawing (DP-EC-RS-A_).

2.6.5 Storm lock



When needed ET end carriages can be equipped with storm lock. NOTE! When ordered, location of the lock must be mentioned (right or left handed end carriage, driving unit side or opposite side of end carriage, dimension from diving wheel). More information from data page drawing (DP-EC-SL-A_).

2.6.6 Polyurethane flat wheels

ES/ET end carriages can be equipped with wheels which have running surfaces coated with polyurethane plastic. Nominal diameter range is from 140 mm to 320 mm. Both idle and driving wheel as non flanged types are available. The wheel body has equal outer dimension and markings as equivalent casted wheel. Coated wheels can be used in corresponding end carriages as casted wheels. The polyurethan flat wheels must be mentioned separately in the end carriage order (special properties).
In general polyurethane coating has following characteristics:

- Ensure silent, smooth running and lower surface pressure under wheel
- Increased friction between rail and wheel
- Rolling resistance about. 1,5…2 times of steel wheel
- High resistance to wearing and tearing and good resistance to mineral oils and greases
- The colour of coating may get darker during time, which doesn't effect to properties

Maximum wheel loads with non flanged wheels are presented in table. The values are limited to following conditions:

- Thickness of coating according to given figures
- Maximum travelling speed 63m/min
- Material of coating: Vulkollan®; hardness 95° Sha
- Operating temperature range -10°C…+30°C
- Running surface can be of steel, concrete or eq. and should be smooth and free from loose particles
- If the wheel is standing still for very long time with load on, there may be small compression in surface, which will disappear during use.

Maximum wheel loads for coated wheels:

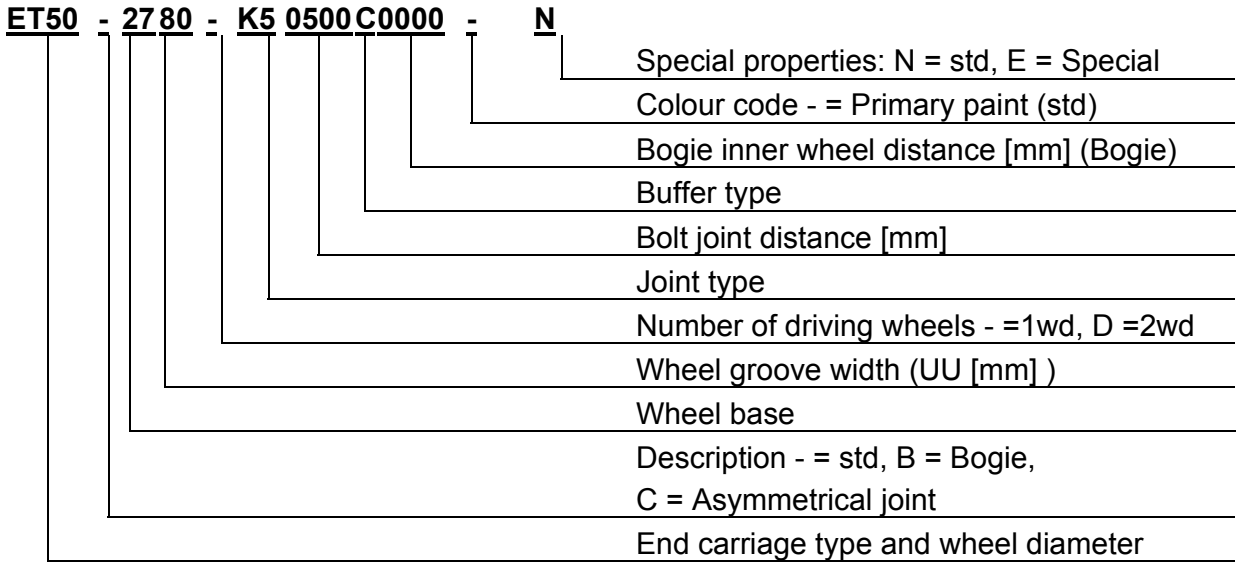
Diameter of wheel, D Thickness of coating; max., h Max width of non flanged wheel, b				
D (mm)=	140	200	250	320
H (mm)=	15	20	25	30
B (mm)=	111	127	133	135
Pdyn max (kN)	21,0	39,9	52,2	65,7

3 ORDERING THE END CARRIAGE

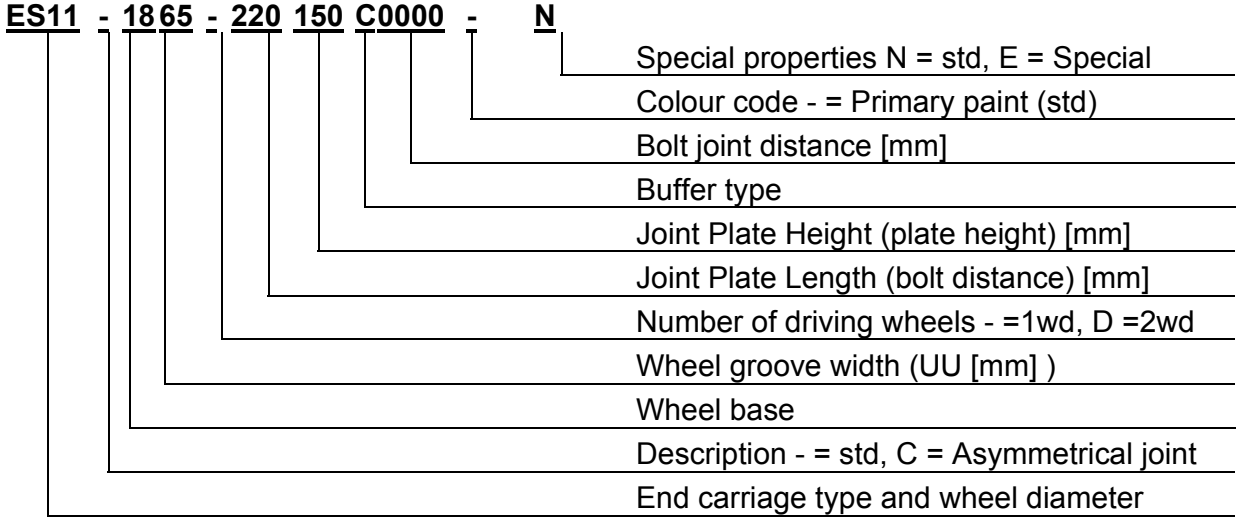
The order code orders a one end carriage. When two end carriages are ordered those are manufactured as a pair; one left- and one right-handed. When only one end carriage is ordered it have to be told if it is left- or right-handed. See section “Traveling Machinery”

3.1 Ordering code of the End Carriage

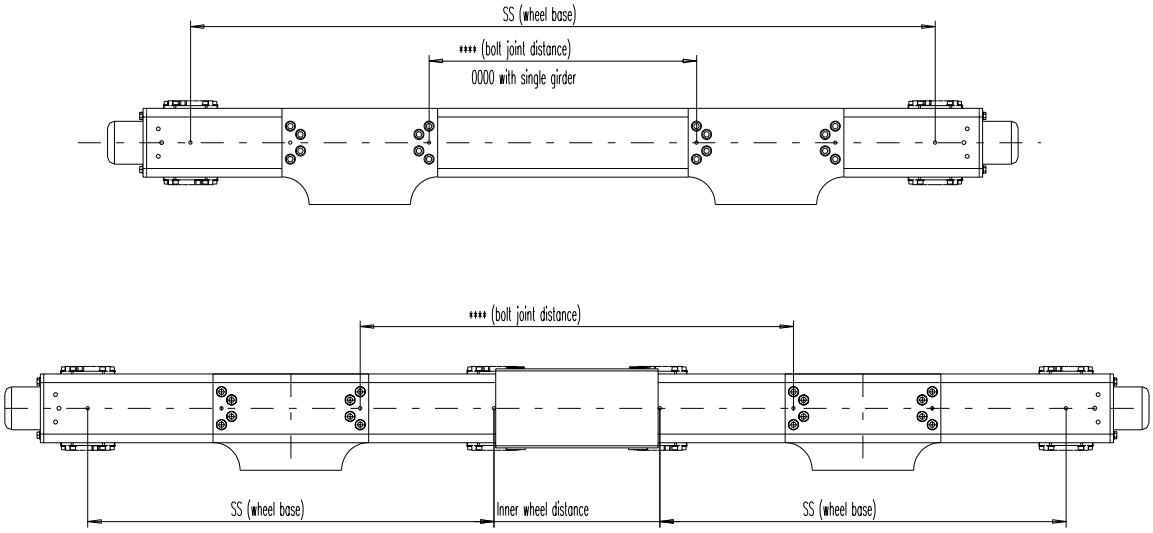
3.1.1 ET Ordering example:



3.1.2 ES Ordering example:



3.2 Dimensions needed when ordering end carriages

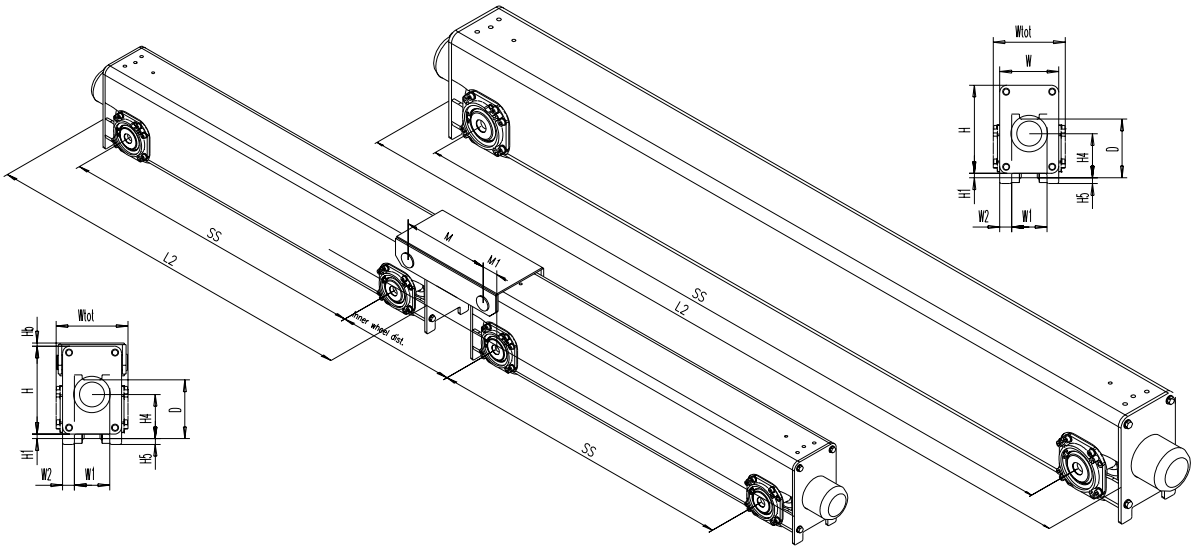


Bolt joint distance is dimension between alignment pins of joint plates. When asymmetrical joint is needed with single girder this is dimension from driving wheel centre to closest alignment pin of joint plate.
Groove width 100mm is marked 99 in code. When the rail wheel is wanted without flanges it is marked 00. NOTE! If end carriage is wanted without derailment guides it have to be ordered with E (special properties) with explanation.

3.3 Data info of the end carriage

End carriage type	Wheel base	Wheel base (bogie)	Groove width	Joint plates
ES11	14,18,22,27		50-75	220x150, 220x300, 220x480
ES14	14,18,22,27,31,38		50-75	220x240, 220x300, 220x480, 300x240, 300x300, 300x480, 410x240, 410x300, 410x480
ET09	14,18,22		50-65	P3
ET11	14,18,22,27		50-75	C1, P4, P6
ET14	14,18,22,27,31,38		50-75	C1, P4, P6
ET20	18,22,27,31,38	12,14,16,18,20	55-100	C4, L3, L4, L5, R3, R4, R5
ET25	22,27,31,38,45,50,55	14,16,18,20	55-100	K4, K5, K7, S4, S5
ET32	22,27,31,38,45,50,55	14,16,18,20	55-100	K4, K5, K7, S4, S5, S6, S7
ET50	22,27,31,38,45,50,55	16,18,20	55-100	K5, K7, S6, S7

4 DIMENSIONS AND VALUES OF END CARRIAGES



End carriage SS (x 100mm)		L2	D	H1	H	H5	H4	Wtot	W	W1	W2	Wgt (kg)	Cross-section A/mm^2	Iy 10^4mm^4	Ix 10^4mm^4
ES11	-14	1590	110	15	150	15	100	195	150	80	32	80	4324	1412	1412
	-18	1990	110	15	150	15	100	195	150	80	32	93	4324	1412	1412
	-22	2390	110	15	150	15	100	195	150	80	32	107	4324	1412	1412
	-27	2890	110	15	150	15	100	195	150	80	32	124	4324	1412	1412
ES14	-14	1620	140	18	250	15	100	199	150	80	32	133	7257	5825	2634
	-18	2020	140	18	250	15	100	199	150	80	32	157	7257	5825	2634
	-22	2420	140	18	250	15	100	199	150	80	32	179	7257	5825	2634
	-27	2920	140	18	250	15	100	199	150	80	32	208	7257	5825	2634
	-31	3320	140	18	250	15	100	199	150	80	32	230	7257	5825	2634
	-38	4020	140	18	250	15	100	199	150	80	32	270	7257	5825	2634
ET09	-14	1570	90	12	120	15	90	165	120	75	19,5	48	2643	562	562
	-18	1970	90	12	120	15	90	165	120	75	19,5	57	2643	562	562
	-22	2370	90	12	120	15	90	165	120	75	19,5	65	2643	562	562
ET11	-14	1590	110	15	150	15	100	195	150	80	32	80	4324	1412	1412
	-18	1990	110	15	150	15	100	195	150	80	32	93	4324	1412	1412
	-22	2390	110	15	150	15	100	195	150	80	32	107	4324	1412	1412
	-27	2890	110	15	150	15	100	195	150	80	32	124	4324	1412	1412
ET14	-14	1620	140	18	250	15	100	199	150	80	32	116	5924	4886	2219
	-18	2020	140	18	250	15	100	199	150	80	32	135	5924	4886	2219
	-22	2420	140	18	250	15	100	199	150	80	32	153	5924	4886	2219
	-27	2920	140	18	250	15	100	199	150	80	32	177	5924	4886	2219
	-31	3320	140	18	250	15	100	199	150	80	32	195	5924	4886	2219
	-38	4020	140	18	250	15	100	199	150	80	32	228	5924	4886	2219
ET20	-18	2080	200	15	300	20	150	244	200	120	40	231	9257	11313	6058

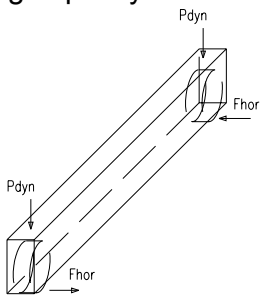
End carriage SS (x 100mm)		L2	D	H1	H	H5	H4	Wtot	W	W1	W2	Wgt (kg)	Cross-section A/mm^2	Iy 10^4mm^4	Ix 10^4mm^4
	-22	2480	200	15	300	20	150	244	200	120	40	260	9257	11313	6058
	-27	2980	200	15	300	20	150	244	200	120	40	297	9257	11313	6058
	-31	3380	200	15	300	20	150	244	200	120	40	326	9257	11313	6058
	-38	4080	200	15	300	20	150	244	200	120	40	377	9257	11313	6058
ET25	-22	2540	250	20	290	20	150	271	270	140	65	376	12960	15181	11158
	-27	3040	250	20	290	20	150	271	270	140	65	426	12960	15181	11158
	-31	3440	250	14	302	20	150	271	270	140	65	551	16200	22279	13126
	-38	4140	250	14	302	20	150	271	270	140	65	641	16200	22279	13126
	-45	4840	250	14	402	20	150	271	270	140	65	681	14560	38955	12811
	-50	5340	250	14	402	20	150	271	270	140	65	739	14560	38955	12811
	-55	5840	250	14	402	20	150	271	270	140	65	796	14560	38955	12811
ET32	-22	2614	320	20	344	20	150	271	270	140	65	488	16720	26602	14822
	-27	3114	320	20	344	20	150	271	270	140	65	544	16720	26602	14822
	-31	3514	320	20	344	20	150	271	270	140	65	596	16720	26602	14822
	-38	4214	320	20	348	20	150	271	270	140	65	733	17800	29834	15478
	-45	4914	320	20	514	20	150	271	270	140	65	766	14320	56518	14309
	-50	5414	320	20	522	20	150	271	270	140	65	921	16480	71008	15621
	-55	5914	320	20	522	20	150	271	270	140	65	987	16480	71008	15621
ET50	-22	2614	500	26	514	18	150	296	290	140	75	790	16760	63465	19472
	-27	3114	500	22	522	18	150	296	290	140	75	900	19080	79028	21098
	-31	3514	500	22	522	18	150	296	290	140	75	960	19080	79028	21098
	-38	4214	500	18	530	18	150	296	290	140	75	1140	21400	95075	22724
	-45	4914	500	22	642	18	150	296	290	140	75	1320	21480	128765	24672
	-50	5414	500	18	650	18	150	296	290	140	75	1490	23800	152969	26298
	-55	5914	500	18	650	18	150	296	290	140	75	1590	23800	152969	26298

End carriage SS (x 100mm)		L2	H1	H	Hb	Wtot	W	W2	M1	Wgt (kg/m) bogie beam	Wgt (kg)	Cross-section A/mm^2	Iy 10^4mm^4	Ix 10^4mm^4
ET20B	-12	1540	15	300	21	244	40	200	65	40	188	9257	11313	6058
	-14	1740	15	300	21	244	40	200	65	40	202	9257	11313	6058
	-16	1940	15	300	21	244	40	200	65	40	217	9257	11313	6058
	-18	2140	15	300	21	244	40	200	65	40	231	9257	11313	6058
	-20	2340	15	300	21	244	40	200	65	40	260	9257	11313	6058
ET25B	-14	1740	20	290	21	276	65	270	110	47	311	12960	15181	11158
	-16	1940	20	290	21	276	65	270	110	47	331	12960	15181	11158
	-18	2140	20	290	21	276	65	270	110	47	351	12960	15181	11158
	-20	2340	20	290	21	276	65	270	110	47	372	12960	15181	11158
ET32B	-14	1814	20	344	21	288	65	270	145	57	406	16720	26602	14822
	-16	2014	20	344	21	288	65	270	145	57	433	16720	26602	14822
	-18	2214	20	344	21	288	65	270	145	57	459	16720	26602	14822
	-20	2414	20	344	21	288	65	270	145	57	486	16720	26602	14822
ET50B	-16	2212	26	514	21	301	65	270	225	80	410	26080	80048	26441
	-18	2412	26	514	21	301	65	270	225	80	450	26080	80048	26441
	-20	2612	26	514	21	301	65	270	225	80	490	26080	80048	26441

Other bogie dimensions as with 2 wheel end carriages.
Total weight with 4 wheel bogies; Wgt x 2 + Wgt(bogie beam) x M

5 CALCULATION INSTRUCTIONS FOR CHECKING THE RAIL WHEELS ACCORDING TO FEM

When choosing end carriages the rail wheel must be checked considering the highest allowed surface pressure and the wheel bearing capacity.



Horizontal forces according to table have been used when designing the end carriages.

Design horizontal forces for the end carriages due to skewing:

Loading case	2-wheel end carriage Pdyn = dynamic wheel load
Case I	Fhor=17.5% * Pdyn
Case II	Fhor=25% * Pdyn
Case III	Fhor=30% * Pdyn

5.1 Checking the Rail Wheels considering the allowed surface pressure

Following things must be checked when choosing the wheel size.
- the static load on the rail wheel
- the rail type
- the speed
- the group classification of the mechanism

The surface pressure is checked by the following formula:

$$\frac{P_{mean}}{b_{eff} * D * c_1 * c_2} \leq P_L$$

D the wheel diameter [mm]
b_{eff} the effective width of the rail [mm]
P_L the permissible surface pressure of the wheel [N/mm^2]
c_1 a coefficient depending on the speed of crane (FEM-std.)
c_2 a coefficient depending on the group of the mechanism (FEM-std.)
P_{mean} the mean load

Rail widths:

Crane rail type A, DIN536 Blatt 1		
Rail	**Rail width b**	**b_{eff}**
A45	45	39,6
A55	55	48,3
A65	65	57
A75	75	64,3
A100	100	86,6
A120	120	106,6

Flat rail		
Rail	**Rail width b**	**b_{eff}**
50 x 30	50	44
60 x 40	60	54
70 x 40	70	64
80 x 60	80	74

5.1.1 Determining the mean load

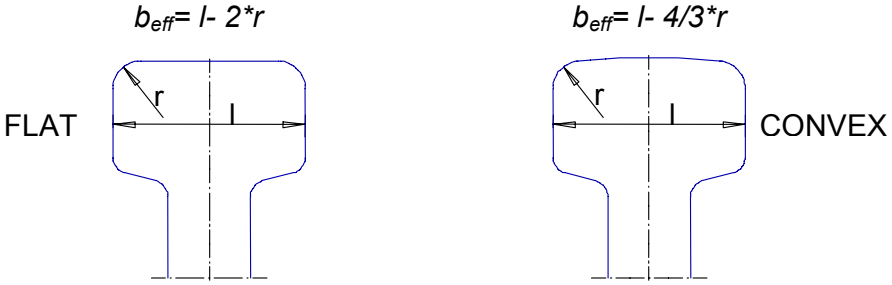
P_{mean} is determined by $P_{statmin}$ and $P_{statmax}$. Dynamic coefficient ψ is not included in the calculation.

$$P_{mean} = \frac{P_{stat\,min} + 2*(P_{stat\,max})}{3}$$

$P_{statmin}$ = minimum static wheel load, $P_{statmax}$ = maximum static wheel load

5.1.2 Determining the mean effective rail width b_{eff}

For rails having a flat or a convex bearing surface and a total width l with rounded corners of radius r at each side:



5.1.3 Determining the limiting pressure P_L valid for ET-end carriages

The ultimate tensile strength for the wheel material is 800 N/mm^2. The permissible surface pressure is P_L = 6,5 N/mm^2.

5.1.4 Determining the coefficient c_1

The values of c_1 are given in table as a function of the wheel diameter and the speed.

Wheel	**Values of c_1 for travel speeds [m/min]**										
diameter [mm]	**10**	**12.5**	**16**	**20**	**25**	**31.5**	**40**	**50**	**63**	**80**	**100**

90	0,99	0,96	0,92	0,89	0,84	0,79	0,75	0,69	0,64	0,59	0,55
110	1,01	0,98	0,95	0,96	0,88	0,84	0,78	0,73	0,69	0,63	0,58
140	1,03	1,01	0,98	0,96	0,92	0,89	0,84	0,79	0,74	0,69	0,63
200	1.09	1.06	1.03	1,00	0.97	0.94	0.91	0.87	0.82	0.77	0.72
250	1.11	1.09	1.06	1.03	1,00	0.97	0.94	0.91	0.87	0.82	0.77
320	1,13	1,11	1,09	1,06	1,03	1,00	0,97	0,94	0,91	0,87	0,82
500	1.15	1.14	1.13	1.11	1.09	1.06	1.03	1,00	0.97	0.94	0.91

5.1.5 Determining the coefficient c2

The coefficient c_2 depends on the group classification of the mechanism and is given in table.

Group classification of mechanism (FEM)	c_2
M1 to M4	1.12
M5	1.0

5.2 Checking the Rail Wheels considering the allowed load due to the bearings

Account shall be taken of the oscillations caused when lifting the load by multiplying the loads by the “dynamic coefficient ψ“. The result of this is compared with the allowed dynamic load of the bearing. P_{maxdyn} may not be higher than the allowed load due to bearing.

6 INFORMATIVE APPENDIX A

Permissible dynamic wheel loads determined by the fatigue strength of the steel structure according to component groups for ET09-ET50 2-wheel end carriages with flanged wheels or guide rollers. (SG).

End carriage	SS	absolut Pdynmax [kN]	casel HImax [kN]	caseIII HIIImax [kN]	P_{dynmax} [kN]			
					E2	E3	E4	E5
ET09	-14	26	4,22	7,24	26	26	26	23
	-18	20	4,22	7,24	20	20	20	18
	-22	16	4,22	7,24	16	16	16	14
ET11/ES11	-14	44	6,64	11,3	44	44	44	39
	-18	41	6,64	11,3	41	41	41	37
	-22	33	6,64	11,3	33	33	33	29
	-27	27	6,64	11,3	27	27	27	24
ET14/ES14	-14	55	8,30	14,2	55	55	55	49
	-18	55	8,30	14,2	55	55	55	49
	-22	55	8,30	14,2	55	55	55	49
	-27	54	8,30	14,2	54	54	54	49
	-31	47	8,30	14,2	47	47	47	42
	-38	39	8,30	14,2	39	39	39	35
ET20	-18	120	18,1	31,0	120	120	120	108
	-22	120	18,1	31,0	120	120	120	108
	-27	106	18,1	31,0	106	106	106	96
	-31	93	18,1	31,0	93	93	93	84
	-38	76	18,1	31,0	76	76	76	68
ET25	-22	185	27,9	47,8	185	185	185	167
	-27	152	27,9	47,8	152	152	152	137
	-31	149	27,9	47,8	149	149	149	135
	-38	150	27,9	47,8	150	150	150	136
	-45	156	27,9	47,8	156	156	156	141
	-50	140	27,9	47,8	140	140	140	127
	-55	128	27,9	47,8	128	128	128	116
ET32	-22	225	33,9	58,2	225	225	225	204
	-27	210	33,9	58,2	210	210	210	190
	-31	185	33,9	58,2	185	185	185	167
	-38	167	33,9	58,2	167	167	167	151
	-45	168	33,9	58,2	168	168	168	152
	-50	182	33,9	58,2	182	182	182	165
	-55	166	33,9	58,2	166	166	166	150
ET50	-22	350	52,8	90,5	350	350	350	317
	-27	350	52,8	90,5	350	350	350	317
	-31	328	52,8	90,5	328	328	328	297
	-38	314	52,8	90,5	314	314	314	284
	-45	295	52,8	90,5	295	295	295	267
	-50	304	52,8	90,5	304	304	304	275
	-55	278	52,8	90,5	278	278	278	252

Permissible dynamic wheel loads determined by the fatigue strength of the steel structure according to component groups for ET09-ET50 2-wheel end carriages with flanged wheels or guide rollers. (DG, Rail gauge=1200, empty row=joint plates don't fit on end carriage with this wheel base/rail gauge).

End carriage	SS	absolut P_{dynmax} [kN]	casel HI_{max} [kN]	caselII $HIII_{max}$ [kN]	P_{dynmax} [kN]			
					E2	E3	E4	E5
ET09	-14							
	-18	28	4,22	7,24	28	28	28	25
	-22	28	4,22	7,24	28	28	28	25
ET11/ES11	-14							
	-18							
	-22	44	6,64	11,3	44	44	44	39
	-27	44	6,64	11,3	44	44	44	39
ET14/ES14	-14							
	-18							
	-22	55	8,30	14,2	55	55	55	49
	-27	55	8,30	14,2	55	55	55	49
	-31	55	8,30	14,2	55	55	55	49
	-38	55	8,30	14,2	55	55	55	49
ET20	-18							
	-22	120	18,1	31,0	120	120	120	108
	-27	120	18,1	31,0	120	120	120	108
	-31	120	18,1	31,0	120	120	120	108
	-38	110	18,1	31,0	110	110	110	99
ET25	-22	185	27,9	47,8	185	185	185	167
	-27	185	27,9	47,8	185	185	185	167
	-31	185	27,9	47,8	185	185	185	167
	-38	185	27,9	47,8	185	185	185	167
	-45	185	27,9	47,8	185	185	185	167
	-50	183	27,9	47,8	183	183	183	166
	-55	161	27,9	47,8	161	161	161	146
ET32	-22							
	-27	225	33,9	58,2	225	225	225	204
	-31	225	33,9	58,2	225	225	225	204
	-38	225	33,9	58,2	225	225	225	204
	-45	225	33,9	58,2	225	225	225	204
	-50	225	33,9	58,2	225	225	225	204
	-55	210	33,9	58,2	210	210	210	190
ET50	-22							
	-27	350	52,8	90,5	350	350	350	317
	-31	350	52,8	90,5	350	350	350	317
	-38	350	52,8	90,5	350	350	350	317
	-45	350	52,8	90,5	350	350	350	317
	-50	350	52,8	90,5	350	350	350	317
	-55	350	52,8	90,5	350	350	350	317

7 DYNAMIC WHEEL LOADS FOR ET09 END CARRIAGES

Permissible dynamic wheel loads determined by the wheel bearings and the surface pressure of the wheels. NOTE: When bearing capacity becomes less than wheel capacity, bearing capacity is shown!

Wheel Diameter	D/mm	90			**NOTE!!!**
Bearing(nro 6207-2Z)	C0=15,30kN, C=25,50kN, Y0=2.8, Y1=3.0				Pdynamax/kN
Basic technical facts	PL N/mm2 6,5	Rail effective width=beff			
	Pdyn/Pstat= 1.15	**Pstatmin/Pstatmax =0.35**			

		CRANE RAILS TYPE A (DIN536 Blatt1)				FLAT RAILS			
			Rail width B (beff)			Rail width B (beff)			
FEM DUTY	Speed m/min	Due to bearing	75 64,3	65 57	55 48,3	80 74	70 64	60 54	50 44
M4	20	28	28	28	28	28	28	28	28
	25	28	28	28	28	28	28	28	28
	32	28	28	28	28	28	28	28	28
	40	28	28	28	28	28	28	28	28
	50	28	28	28	28	28	28	28	28
	63	28	28	28	28	28	28	28	27
	80	28	28	28	27	28	28	28	24
	100	26	26	26	25	26	26	26	23
M5	20	28	28	28	28	28	28	28	28
	25	28	28	28	28	28	28	28	28
	32	28	28	28	28	28	28	28	28
	40	28	28	28	28	28	28	28	28
	50	26	26	26	26	26	26	26	26
	63	24	24	24	24	24	24	24	24
	80	22	22	22	22	22	22	22	22
	100	21	21	21	21	21	21	21	20
M6	20	28	28	28	28	28	28	28	28
	25	26	26	26	26	26	26	26	26
	32	24	24	24	24	24	24	24	24
	40	22	22	22	22	22	22	22	22
	50	21	21	21	21	21	21	21	21
	63	19	19	19	19	19	19	19	19
	80	18	18	18	18	18	18	18	18
	100	16	16	16	16	16	16	16	16

8 DYNAMIC WHEEL LOADS FOR ET11 END CARRIAGES

Permissible dynamic wheel loads determined by the wheel bearings and the surface pressure of the wheels. NOTE: When bearing capacity becomes less than wheel capacity, bearing capacity is shown!

Wheel Diameter	D/mm	110			**NOTE!!!**
Bearing(nro 6308-2Z)	C0=24,00kN, C=41,00kN, Y0=2.8, Y1=3.0				Pdynamax/kN
Basic technical facts	PL N/mm2 6,5		Rail effective width=beff		
	Pdyn/Pstat= 1.15		**Pstatmin/Pstatmax =0.35**		

		CRANE RAILS TYPE A (DIN536 Blatt1)				FLAT RAILS			
			Rail width B (beff)			Rail width B (beff)			
FEM DUTY	Speed m/min	Due to bearing	75 64,3	65 57	55 48,3	80 74	70 64	60 54	50 44
M4	20	44	44	44	44	44	44	44	44
	25	44	44	44	44	44	44	44	44
	32	44	44	44	44	44	44	44	43
	40	44	44	44	44	44	44	44	40
	50	44	44	44	41	44	44	44	37
	63	44	44	44	39	44	44	43	35
	80	44	44	42	35	44	44	39	32
	100	44	43	38	32	44	43	36	30
M5	20	44	44	44	44	44	44	44	42
	25	44	44	44	44	44	44	44	40
	32	44	44	44	42	44	44	44	38
	40	44	44	44	39	44	44	44	36
	50	44	44	43	37	44	44	41	33
	63	42	42	41	34	42	42	39	31
	80	39	39	37	31	39	39	35	29
	100	36	36	34	29	36	36	32	26
M6	20	44	44	44	41	44	44	44	37
	25	44	44	44	40	44	44	44	36
	32	42	42	42	38	42	42	42	34
	40	39	39	39	35	39	39	39	32
	50	36	36	36	33	36	36	36	30
	63	33	33	33	31	33	33	33	28
	80	31	31	31	28	31	31	31	26
	100	28	28	28	26	28	28	28	24

9 DYNAMIC WHEEL LOADS FOR ET14 END CARRIAGES

Permissible dynamic wheel loads determined by the wheel bearings and the surface pressure of the wheels. NOTE: When bearing capacity becomes less than wheel capacity, bearing capacity is shown!

Wheel Diameter	D/mm	140			**NOTE!!!**
Bearing(nro 6211-2Z)	C0=29,00kN, C=43,60kN, Y0=2.8, Y1=3.0				Pdynamax/kN
Basic technical facts	PL N/mm2 6,5	Rail effective width=beff			
	Pdyn/Pstat= 1.15	**Pstatmin/Pstatmax =0.35**			

		CRANE RAILS TYPE A (DIN536 Blatt1)				FLAT RAILS			
			Rail width B (beff)			Rail width B (beff)			
FEM DUTY	Speed m/min	Due to bearing	75 64,3	65 57	55 48,3	80 74	70 64	60 54	50 44
M4	20	55	55	55	55	55	55	55	55
	25	55	55	55	55	55	55	55	55
	32	55	55	55	55	55	55	55	55
	40	55	55	55	55	55	55	55	55
	50	55	55	55	55	55	55	55	52
	63	55	55	55	53	55	55	55	48
	80	55	55	55	49	55	55	55	45
	100	52	52	52	45	52	52	50	41
M5	20	55	55	55	55	55	55	55	55
	25	55	55	55	55	55	55	55	54
	32	55	55	55	55	55	55	55	52
	40	55	55	55	54	55	55	55	49
	50	51	51	51	50	51	51	51	46
	63	48	48	48	47	48	48	48	43
	80	44	44	44	44	44	44	44	40
	100	41	41	41	40	41	41	41	37
M6	20	55	55	55	55	55	55	55	50
	25	52	52	52	52	52	52	52	48
	32	48	48	48	48	48	48	48	47
	40	44	44	44	44	44	44	44	44
	50	41	41	41	41	41	41	41	41
	63	38	38	38	38	38	38	38	38
	80	35	35	35	35	35	35	35	35
	100	32	32	32	32	32	32	32	32

10 DYNAMIC WHEEL LOADS FOR ET20 END CARRIAGES

Permissible dynamic wheel loads determined by the wheel bearings and the surface pressure of the wheels. NOTE: When bearing capacity becomes less than wheel capacity, bearing capacity is shown!

Wheel Diameter	D/mm	200			**NOTE!!!**
Bearing(nro 22213)	C0=183,00kN, C=148,00kN, Y0=2.8, Y1=3.0				Pdynamax/kN
Basic technical facts	PL N/mm2 6,5		Rail effective width=beff		
	Pdyn/Pstat= 1.15		**Pstatmin/Pstatmax =0.35**		

		CRANE RAILS TYPE A (DIN536 Blatt1)				FLAT RAILS			
			Rail width B (beff)			Rail width B (beff)			
FEM DUTY	Speed m/min	Due to bearing	75 64,3	65 57	55 48,3	80 74	70 64	60 54	50 44
M4	20	120	120	120	103	120	120	115	94
	25	120	120	118	100	120	120	111	91
	32	120	120	114	97	120	120	108	88
	40	120	120	110	93	120	120	105	85
	50	120	119	106	89	120	119	100	81
	63	120	112	99	84	120	112	94	77
	80	120	105	93	79	120	105	88	72
	100	120	98	87	74	113	98	83	67
M5	20	120	120	108	92	120	120	103	83
	25	120	119	105	89	120	118	99	81
	32	120	115	102	86	120	114	96	78
	40	120	111	98	83	120	111	93	76
	50	120	106	94	80	120	106	89	73
	63	120	100	89	75	115	100	84	68
	80	114	94	83	70	108	94	79	64
	100	106	88	78	66	101	87	74	60
M6	20	120	110	97	82	120	109	92	75
	25	120	107	94	80	120	106	89	73
	32	120	103	92	77	119	103	87	71
	40	117	100	89	75	115	100	84	68
	50	108	96	85	72	108	95	80	65
	63	100	90	80	68	100	90	76	61
	80	92	85	75	63	92	84	71	58
	100	86	79	70	59	86	79	66	54

11 DYNAMIC WHEEL LOADS FOR ET25 END CARRIAGES

Permissible dynamic wheel loads determined by the wheel bearings and the surface pressure of the wheels. NOTE: When bearing capacity becomes less than wheel capacity, bearing capacity is shown!

Wheel Diameter	D/mm	250			**NOTE!!!**
Bearing(nro 22216)	C0=228,00kN, C=176,00kN, Y0=2.8, Y1=3.0				Pdynamax/kN
Basic technical facts	PL N/mm2 6,5	Rail effective width=beff			
	Pdyn/Pstat= 1.15	**Pstatmin/Pstatmax =0.35**			

		CRANE RAILS TYPE A (DIN536 Blatt1)				FLAT RAILS			
			Rail width B (beff)			Rail width B (beff)			
FEM DUTY	Speed m/min	Due to bearing	75 64,3	65 57	55 48,3	80 74	70 64	60 54	50 44
M4	20	185	176	156	132	185	176	148	121
	25	185	171	152	129	185	171	144	117
	32	185	166	147	125	185	165	139	114
	40	185	161	143	121	185	160	135	110
	50	185	156	138	117	179	155	131	106
	63	183	149	132	112	172	148	125	102
	80	169	140	124	105	162	140	118	96
	100	157	132	117	99	152	131	111	90
M5	20	185	157	140	118	181	157	132	108
	25	185	153	135	115	176	152	128	104
	32	185	148	131	111	171	148	124	101
	40	173	144	127	108	165	143	121	98
	50	160	139	123	104	160	138	117	95
	63	148	133	118	100	148	132	112	91
	80	137	125	111	94	137	125	105	86
	100	127	118	104	88	127	117	99	80
M6	20	177	142	126	106	163	141	119	97
	25	164	138	122	103	158	137	115	94
	32	151	133	118	100	151	133	112	91
	40	140	129	115	97	140	129	108	88
	50	130	125	111	94	130	125	105	85
	63	120	120	106	90	120	119	100	82
	80	111	111	100	85	111	111	95	77
	100	103	103	94	79	103	103	89	72

12 DYNAMIC WHEEL LOADS FOR ET32 END CARRIAGES

Permissible dynamic wheel loads determined by the wheel bearings and the surface pressure of the wheels. NOTE: When bearing capacity becomes less than wheel capacity, bearing capacity is shown!

Wheel Diameter	D/mm	320			**NOTE!!!**
Bearing(nro 22216)	C0=228,00kN, C=176,00kN, Y0=2.8, Y1=3.0				Pdynamax/kN
Basic technical facts	PL N/mm2 6,5		Rail effective width=beff		
	Pdyn/Pstat= 1.15		**Pstatmin/Pstatmax =0.35**		

		CRANE RAILS TYPE A (DIN536 Blatt1)				FLAT RAILS			
			Rail width B (beff)			Rail width B (beff)			
FEM DUTY	Speed m/min	Due to bearing	75 64,3	65 57	55 48,3	80 74	70 64	60 54	50 44
M4	20	225	225	206	175	225	225	195	159
	25	225	225	200	170	225	225	190	154
	32	225	219	194	165	225	218	184	150
	40	221	213	189	160	221	212	179	145
	50	206	206	183	155	206	205	173	141
	63	193	193	177	150	193	193	168	136
	80	179	179	169	143	179	179	160	130
	100	168	168	159	135	168	168	151	123
M5	20	221	208	184	156	221	207	174	142
	25	207	202	179	151	207	201	169	138
	32	192	192	174	147	192	192	164	134
	40	180	180	168	143	180	180	159	130
	50	168	168	163	138	168	168	155	126
	63	157	157	157	134	157	157	150	122
	80	146	146	146	128	146	146	143	116
	100	136	136	136	120	136	136	135	110
M6	20	180	180	166	140	180	180	157	128
	25	168	168	161	136	168	168	152	124
	32	156	156	156	132	156	156	148	120
	40	146	146	146	128	146	146	143	117
	50	136	136	136	124	136	136	136	113
	63	127	127	127	120	127	127	127	110
	80	118	118	118	115	118	118	118	105
	100	111	111	111	108	111	111	111	99

13 DYNAMIC WHEEL LOADS FOR ET50 END CARRIAGES

Permissible dynamic wheel loads determined by the wheel bearings and the surface pressure of the wheels. NOTE: When bearing capacity becomes less than wheel capacity, bearing capacity is shown!

Wheel Diameter	D/mm	500			**NOTE!!!**
Bearing(nro 22220)	C0=415,00kN, C=311,00kN, Y0=2.8, Y1=3.0				Pdynamax/kN
Basic technical facts	PL N/mm2 6,5	Rail effective width=beff			
	Pdyn/Pstat= 1.15	**Pstatmin/Pstatmax =0.35**			

		CRANE RAILS TYPE A (DIN536 Blatt1)				FLAT RAILS			
			Rail width B (beff)			Rail width B (beff)			
FEM DUTY	Speed m/min	Due to bearing	75 64,3	65 57	55 48,3	80 74	70 64	60 54	50 44
M4	20	350	350	338	286	350	350	320	260
	25	350	350	332	281	350	350	314	256
	32	350	350	322	273	350	350	305	249
	40	350	350	313	265	350	350	297	242
	50	350	343	304	258	350	342	288	235
	63	350	333	295	250	350	331	279	228
	80	350	322	286	242	350	321	271	221
	100	350	312	277	234	350	311	262	213
M5	20	350	340	301	255	350	338	285	233
	25	350	334	296	251	350	332	280	228
	32	350	325	288	244	350	323	273	222
	40	350	315	280	237	350	314	265	216
	50	350	306	271	230	350	305	257	209
	63	326	297	263	223	326	296	249	203
	80	304	288	255	216	304	287	242	197
	100	284	279	247	209	284	277	234	191
M6	20	350	306	271	230	350	305	257	209
	25	350	300	266	226	346	299	252	205
	32	325	292	259	219	325	291	245	200
	40	304	284	252	213	304	283	238	194
	50	284	276	244	207	284	274	231	188
	63	265	265	237	201	265	265	224	183
	80	247	247	230	194	247	247	217	177
	100	231	231	222	188	231	231	211	171

14 TYPE MARKING FOR ES – END CARRIAGES

TYPE MARKING FOR ES- END CARRIAGES

ES11 ***END CARRIAGE TYPE and WHEEL DIAMETER***
ES11, ES14
Wheel diameter 11=110mm, 14=140mm

- ***DESCRIPTION***
- *Standard*
C *Asymmetrical joint with single girder*

27 ***WHEELBASE (100 mm)***
ES11 *14, 18, 22, 27*
ES14 *14, 18, 22, 27, 31, 38*

80 ***GROOVE WIDTH (mm)***
ES11 *50-75*
ES14 *50-75*

- ***NUMBER OF DRIVING WHEELS***
- *One driving wheel/end carriage* °■■■■■■■■
D *Two driving wheels/end carriage* °■■■■■■■■°

ES11 - 18 65 - 220 150 C 0000 - N

Joint Plate Length (distance between bolts)
ES11 *220*
ES14 *220, 300, 410*

Length	*Description*
220	*Profile girder, B=300*
300	*Box girder, B=300*
410	*Box girder, B=410*

Joint Plate Height
ES11 *150, 300, 480*
ES14 *240, 300, 480* ***150***

BUFFER TYPE
0 (zero) = no buffer, A, B, C, D, E, F, H, I, M, P, S ***C***

BOLT JOINT DISTANCE (mm)
Joint plate distance from pin centers with double girder ***0000***
0000 (zero) = with single girder, dimension from driving wheel to pin with asymmetrical joint

COLOUR CODE
- *Standard primary paint* ***-***
S *Sonderanstrich*

SPECIAL PROPERTIES
N *Standard* ***N***
E *Special*

15 TYPE MARKING FOR ET – END CARRIAGES

TYPE MARKING FOR ET- END CARRIAGES

ET50 — ***END CARRIAGE TYPE and WHEEL DIAMETER***
ET09, ET11, ET14, ET20, ET25, ET32, ET50
Wheel diameter 09=90mm, 11=110mm, 14=140mm, 20=200mm, 25=250mm, 32=320mm, 50 = 500 mm

- — ***DESCRIPTION***
- *Standard*
- *B Bogie (with ET20, -25, -32 and –50)*
- *C Asymmetrical joint with single girder*

27 — ***WHEELBASE (100 mm)***

ET09	14, 18, 22
ET11	14, 18, 22, 27
ET14	14, 18, 22, 27, 31, 38
ET20	18, 22, 27, 31, 38
ET25	22, 27, 31, 38, 45, 50, 55
ET32	22, 27, 31, 38, 45, 50, 55
ET50	22, 27, 31, 38, 45, 50, 55

80 — ***GROOVE WIDTH (mm)***

ET09	50-65
ET11	50-75
ET14	50-75
ET20	55-100 (100 is 99 in code)
ET25	55-100 (100 is 99 in code)
ET32	55-100 (100 is 99 in code)
ET50	55-100 (100 is 99 in code)

- — ***NUMBER OF DRIVING WHEELS***
- *-* — *One driving wheel/end carriage*
- *D* — *Two driving wheels/end carriage*
- *S* — *One driving wheel/travel bogie pair*
- *D* — *Two driving wheels/travel bogie pair*

ET50 - 27 80 - K5 0500 C 0000 - N

JOINT TYPE, TOP

ET09	P3
ET11, -14	P4, P6
ET20	L3, L4 ,L5
ET25, -32, -50	K5, K7

JOINT TYPE,SIDE

ET20	R3, R4, R5
ET25, -32, -50	

Code	Description
P3	4 -bolt bolt connection (B < 310 mm)
P4	4 -bolt bolt connection (B < 350 mm)
P6	4 -bolt bolt connection (B < 550 mm)
L3	8 -bolt bolt connection (B < 300 mm)
L4	8 -bolt bolt connection (B < 410 mm)
L5	8 -bolt bolt connection (B < 520 mm)
K5	12-bolt bolt connection (B < 520 mm)
K7	12-bolt bolt connection (B < 740 mm)

BOLT JOINT DISTANCE (mm)
Joint plates distance from alignment pin centers with double girder.
0000 (zero) with single girder, dimension from driving wheel to pin with asymmetrical joint. — ***0500***

BUFFER TYPE
0 (zero) = no buffer, A, B, C, D, E, F, H, I, M, P, S — ***C***

BOGIE INNER WHEEL DISTANCE (mm)
0000 (zero) = no bogie type end carriage — ***0000***

COLOUR CODE
- *Standard primary paint* — ***-***
- *S Special paint*

SPECIAL PROPERTIES
- *N Standard*
- *E Special* — ***N***