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Design Aid
Crane girders of rolled sections in S355

Predesign tables of optimised rolled sections in S355 for crane runway beams

With the introduction of the Eurocodes the calculation of crane runway girders also changes. The aim of this Design Aid is to provide predesign tables according to EN1993-6 from which optimised rolled section sizes for crane runway girders can be taken as a function of the spans and the wheel loads.

The predesign tables were calculated for the standard cases single-span and two-span crane girders, on which a single travelling crane of the crane class S_2 is running. The tables allow a safe-side estimation of the required section size in the steel grade S355. Table 2 can also be applied for crane runway girders with multi-spans.

The sections given in the tables allow a predesign. However, in no case they replace the full-fledged design of load-carrying capacity and serviceability.

The predesign tables are based on the following parameters:

- Steel grade S355
- Hoisting class HC2, crane class S_2
- Flat bar rail b/h = 5 cm / 3 cm
- Two axes with crane chassis system IFF, axle base a, side guidance by wheel flanges
- Wheel loads Q_r of front and rear axle are identical
- Horizontal load H_s from oblique run corresponds to 30 % of a maximum wheel load $Q_{r,max}$ (maximum theoretical value)
- Speed of lift: 5 m / min
- Limiting values of vertical deflection: $\delta_z \leq l/600$
- Limiting value of horizontal deflection: $\delta_y \leq l/600$
- Spacing between the centers of crane rails: 20.00 m
- Minimum distance from the hook's center of gravity to the center of crane rails: 1.00 m

Linearly determined wheel load shares for crane self-weight $Q_{r,c}$, hoisting load $Q_{r,h}$ and mass force H_{T1}, as a function of the crane load-carrying capacity we are used[6].

Table 1: Selection of rolled section size for single-span crane girders

Q_r	a	Predesign table for single-span girders with HE-, HD-, HL-sections in S355					
[kN]	[m]	l=5m	l=6m	l=7m	l=8m	l=10m	l=12m
20	1.6	HD260x54.1	HEA260 *	HD320x74.2	HEA300 *	HEA400	HD360x147 *
20	2.0	HEA220 *	HEA240 *	HD320x74.2	HEA300 *	HEA400	HD360x147 *
20	2.5	HEA220 **	HD260x54.1	HD320x74.2	HD320x74.2	HEA360	HD360x147 *
25	1.6	HD260x54.1	HD320x74.2	HEA300	HEA320	HD360x134 *	HD360x179 *
25	2.0	HD260x54.1	HEA260	HD320x74.2	HEA320	HD360x134 *	HD360x179 *
25	2.5	HD260x54.1 **	HEA260	HD320x74.2	HEA320	HD360x134 *	HD360x179 *
30	1.6	HEA260	HD320x74.2	HEA300	HEA340	HD360x134 *	HD360x196 *
30	2.0	HEA240 **	HD320x74.2	HEA300	HEA340	HD360x134 *	HD360x196 *
30	2.5	HD260x54.1 **	HD320x74.2	HEA300	HEA340 **	HD360x134 *	HD360x196 *
30	3.2	HD260x54.1	HD320x74.2 **	HEA300 **	HEA320 **	HD360x134 *	HD400x187 *
30	4.0	HEA240	HD320x74.2 **	HEA300 **	HEA320 **	HD360x134 *	HD360x179 *
35	1.6	HEA260	HEA300	HEA320	HEA400 **	HD360x147 *	HD400x237 *
35	2.0	HEA260	HD320x74.2	HEA320	HEA400 **	HD360x147 *	HD400x237 *
35	2.5	HEA260 **	HD320x74.2	HEA320 **	HEA400 **	HD360x147 *	HD400x237 *
35	3.2	HEA260 **	HD320x74.2 **	HEA300 **	HEB300 *	HD360x147 *	HD400x216 *
35	4.0	HEA260	HD320x74.2 **	HEA300 **	HEB300 **	HD360x134 *	HD360x196 *
40	2.0	HD320x74.2	HEA300	HEA340 **	HD360x134 *	HD360x162 *	HD400x262 *
40	2.5	HEA260 **	HEA300	HEA340 **	HEB320	HD360x162 *	HD400x262 *
40	3.2	HEA260	HEA300 **	HEA340 **	HEB320 **	HD360x162 *	HD400x237 *
40	4.0	HD320x74.2	HEA300 **	HEA340 **	HEB320 **	HD360x147 *	HD400x237 *
50	2.0	HD320x74.2	HEA320	HEB320	HD360x134 *	HD400x216 *	HD400x314 *
50	2.5	HD320x74.2	HEA320 **	HEB320 **	HD360x134 *	HD360x196 *	HD400x314 *
50	3.2	HD320x74.2	HEA320 **	HEB320 **	HD360x134 *	HD400x187 *	HD400x287 *
50	4.0	HEA300	HEA320 **	HEB320 **	HD360x134 **	HD360x179 *	HD400x262 *
60	2.0	HEA300	HEA360 **	HD360x134	HD360x147	HD400x237 *	HL920x344
60	2.5	HEA300	HEA360 **	HD360x134	HD360x147 *	HD400x237 *	HL920x344
60	3.2	HEA300	HEA360 **	HD360x134	HD360x134	HD400x216 *	HL920x344
60	4.0	HEA320 **	HEA360 **	HD360x134 **	HD360x134 **	HD400x216 *	HD400x314 *
70	2.0	HEA320 **	HEB320 **	HD360x134	HD360x179 *	HD400x262 *	HL920x344 **
70	2.5	HEA320 **	HEB320 **	HD360x134	HD360x162 *	HD400x262 *	HL920x344 **
70	3.2	HEA320 **	HEB320 **	HD360x134	HD360x162 *	HD400x262 *	HL920x344 **
70	4.0	HEA320	HEB320 **	HD360x134 **	HD360x147 **	HD400x237 *	HL920x344 **
80	2.5	HEA340 **	HD360x134	HD360x147	HD360x179 *	HD400x287 *	HL920x368 **
80	3.2	HEA340 **	HD360x134	HD360x134	HD360x179 *	HD400x287 *	HL920x368 **
80	4.0	HEA340 **	HD360x134	HD360x134 **	HD360x162 **	HD400x262 *	HL920x368 **
80	4.6	HEA360	HD360x134	HD360x134	HD360x162 **	HD400x262 *	HL920x368 **
90	2.5	HEB300 **	HD360x134	HD360x162 *	HD360x196 *	HD400x314 *	HL920x420 **
90	3.2	HEB300 **	HD360x134	HD360x147	HD400x187 *	HD400x314 *	HL920x420 **
90	4.6	HEA400 **	HD360x134	HD360x147	HD360x179 **	HD400x262 *	HL920x420 **
100	2.5	HEB320 **	HD360x134	HD360x162	HD400x216 *	HL920x344	HL920x449 **
100	3.2	HEB320 **	HD360x134	HD360x162 **	HD400x216 *	HL920x344	HL920x449 **
120	2.9	HD360x134	HD360x147	HD400x187 *	HD400x262 *	HD400x382	HL920x537 **
140	2.9	HD360x134	HD360x162 **	HD400x216 *	HD400x287 *	HL920x420 **	HL920x588 **
160	3.2	HD360x162	HD360x179 **	HD400x237 *	HD400x314 *	HL920x491 **	HL920x656 **
180	3.2	HD360x162	HD400x187 **	HD400x262 *	HD400x347	HL920x537 **	HL920x725 **
200	3.2	HD360x162	HD400x216 **	HD400x262 *	HD400x382	HL920x588 **	HL920x787 **

* The limiting value of vertical deflection δ_z = l/600 considered in the calculations is decisive

Table 2: Selection of rolled section size for two-span crane girders

Q_r	a	Predesign table for two-span girders with HE-, HD-, HL-sections in S355			
[kN]	[m]	l=5m	l=6m	l=7m	l=8m
20	1.6	HEA220 *	HD260x54.1	HEA260	HD320x74.2
20	2.0	HEA200 **	HEA220 *	HD260x54.1	HD320x74.2
20	2.5	HEA200 **	HEA220 **	HD260x54.1	HEA260 *
25	1.6	HEA220 *	HD260x54.1	HEA260	HD320x74.2
25	2.0	HEA220 **	HD260x54.1	HEA260	HD320x74.2
25	2.5	HEA220 **	HD260x54.1	HEA260	HD320x74.2
30	1.6	HD260x54.1	HEA260	HD320x74.2	HEA300
30	2.0	HEA220 **	HEA260	HD320x74.2	HEA300
30	2.5	HEA220 **	HEA260	HD320x74.2	HEA300
30	3.2	HEA220 **	HD260x54.1 **	HD320x74.2 **	HD320x74.2 **
30	4.0	HEA220 **	HD260x54.1 **	HD320x74.2 **	HD320x74.2 **
35	1.6	HD260x54.1	HD320x74.2	HEA300	HEA320
35	2.0	HD260x54.1	HEA260	HD320x74.2	HEA320 **
35	2.5	HD260x54.1	HEA260	HD320x74.2	HEA300
35	3.2	HD260x54.1 **	HEA260 **	HD320x74.2 **	HEA300 **
35	4.0	HD260x54.1 **	HEA260 **	HD320x74.2 **	HEA300 **
40	2.0	HEA240 **	HD320x74.2	HEA300	HEA320
40	2.5	HD260x54.1	HD320x74.2	HEA300	HEA320 **
40	3.2	HD260x54.1 **	HD320x74.2 **	HEA300 **	HEA320 **
40	4.0	HD260x54.1 **	HD320x74.2 **	HEA300 **	HEA320 **
50	2.0	HEA260	HEA300	HEA320 **	HEA400 **
50	2.5	HEA260	HD320x74.2	HEA320 **	HEB300 *
50	3.2	HEA260 **	HD320x74.2 **	HEA320 **	HEB300 **
50	4.0	HEA260 **	HD320x74.2 **	HEA320 **	HEB300 **
60	2.0	HD320x74.2	HEA320 **	HEA360 **	HD360x134
60	2.5	HD320x74.2	HEA300	HEA360 **	HD360x134
60	3.2	HD320x74.2	HEA300	HEA360 **	HD360x134
60	4.0	HD320x74.2 **	HEA300 **	HEA360 **	HD360x134 **
70	2.0	HEA300	HEA320 **	HEB320 **	HD360x134
70	2.5	HEA300	HEA320 **	HEB320 **	HD360x134
70	3.2	HD320x74.2	HEA320 **	HEB320 **	HD360x134
70	4.0	HD320x74.2 **	HEA320 **	HEB320 **	HD360x134 **
80	2.5	HEA300	HEA340 **	HD360x134	HD360x134
80	3.2	HEA300	HEA340 **	HD360x134	HD360x134
80	4.0	HEA300 **	HEA340 **	HD360x134 **	HD360x134 **
80	4.6	HEA300 **	HEA340 **	HD360x134 **	HD360x134 **
90	2.5	HEA320 **	HEB300 **	HD360x134	HD360x147
90	3.2	HEA300	HEB300 **	HD360x134	HD360x147
90	4.6	HEA300 **	HEB300 **	HD360x134 **	HD360x134 **
100	2.5	HEA320 **	HD360x134	HD360x134	HD360x162 *
100	3.2	HEA320 **	HD360x134	HD360x134	HD360x162 **
120	2.9	HEA360 **	HD360x134	HD360x162 **	HD360x179
140	2.9	HEB320 **	HD360x147	HD360x162 **	HD400x216 *
160	3.2	HD360x134	HD360x162 **	HD360x179 **	HD400x216 *
180	3.2	HD360x134	HD360x162 **	HD400x187	HD400x237 *
200	3.2	HD360x147	HD360x179 **	HD400x216	HD400x262 *

** The limiting value of horizontal deflection δ_y = l/600 considered in the calculations is decisive

The section with the smallest cross section surface, the lowest weight and therefore the lowest costs is given in each case.

The most conservative criteria from the Eurocodes and the German National Annex were chosen for the calculations in order to make them safely applicable in most member states of the European Union.

In detail the limiting values of deflections $\delta_y = \delta_z \leq l/600$ and $\delta_z \leq 25$ mm were fixed for the Serviceability Limit States (SLS). According to the German National Annex to EN1993-6, the less severe criterion $\delta_z \leq l/500$ and $\delta_z \leq 25$ mm is allowed for the horizontal deflection. As a result the given section sizes may be further optimised in Germany in the cases in which this criterion is decisive.

For the stability proofs the partial factor $\gamma_{M1} = 1.1$ introduced in the German National Annex was used. The recommended value in EN1993-1-1 is $\gamma_{M1} = 1.0$, which is confirmed by several National Annexes of the other European member states. Therefore the possibility of optimisation of the sections specified in the predesign tables exists for steel construction projects in other EU member states and in the cases in which stability proofs are decisive.

The utilisation of the section sizes given in the predesign tables is very good for both Serviceability and Ultimate Limit State criteria (ULS).

All table values were determined considering the highest possible horizontal force (oblique run force). Especially with side guidance by side rollers the horizontal forces may be much lower. Smaller section sizes can thereby arise in the specific case.

For crane runway girders with high fatigue loading the fatigue design may become decisive. The predesign tables were determined considering the low crane class S_2.

Often the limiting values of deflection are decisive for the section sizes. In the predesign tables such sections are marked with asterisks, see pages 2/3.

Literature

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