



sin- BEAMS



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Zeman & Co

Denmark; 13.11.2014



SIN BEAMS

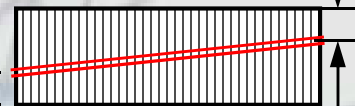
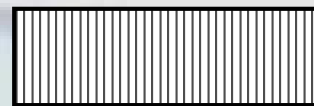


web: **coil material**
1000, 1250, 1500 mm coil width = web height
333, 500, 625, 750 mm by splitting
1,5; 2,0; 2,5; 3,0 ... 6,0 mm thickness

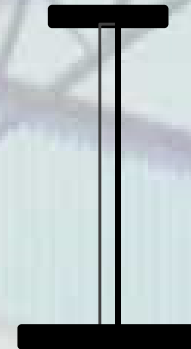
flanges: hot rolled **strips or plate material**
6 ... 30 mm thickness
120 ... 450 mm width

steel grades: **S 235 ... S 355**

parallel or **tapered**



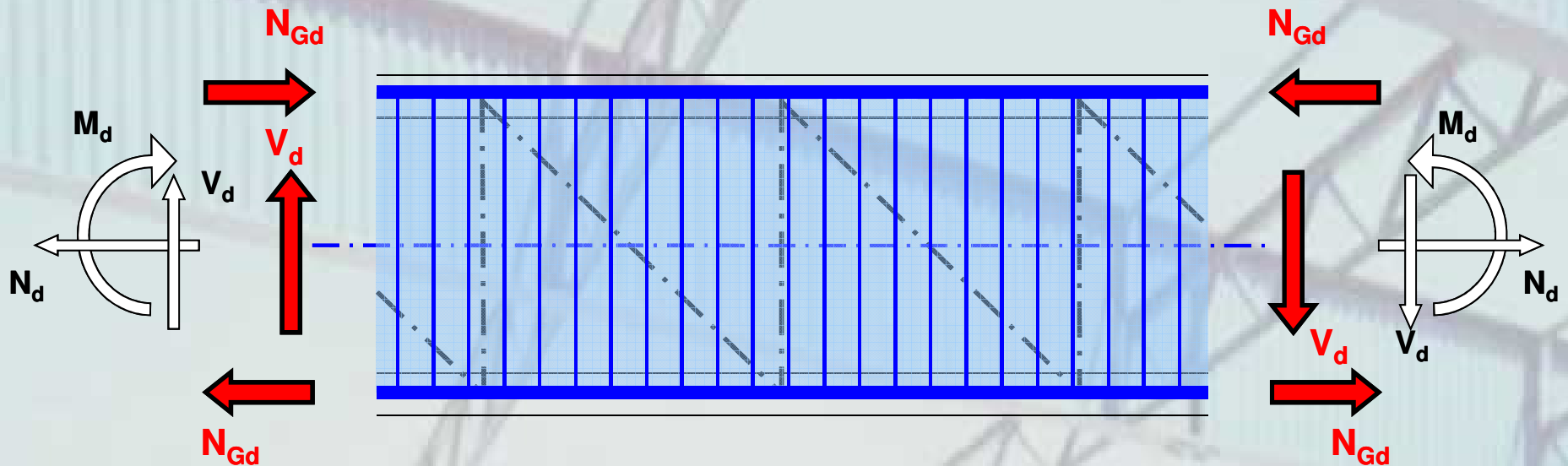
min 250 mm





ADVANTAGE

Simple mechanical model lattice girder



sin - beam



SIMPLE DESIGN



 **sin-beam = lattice girder**

defined at all national standards worldwide

EUROCODE,
ASCI, SNIP, CN, ...

flanges



web ?

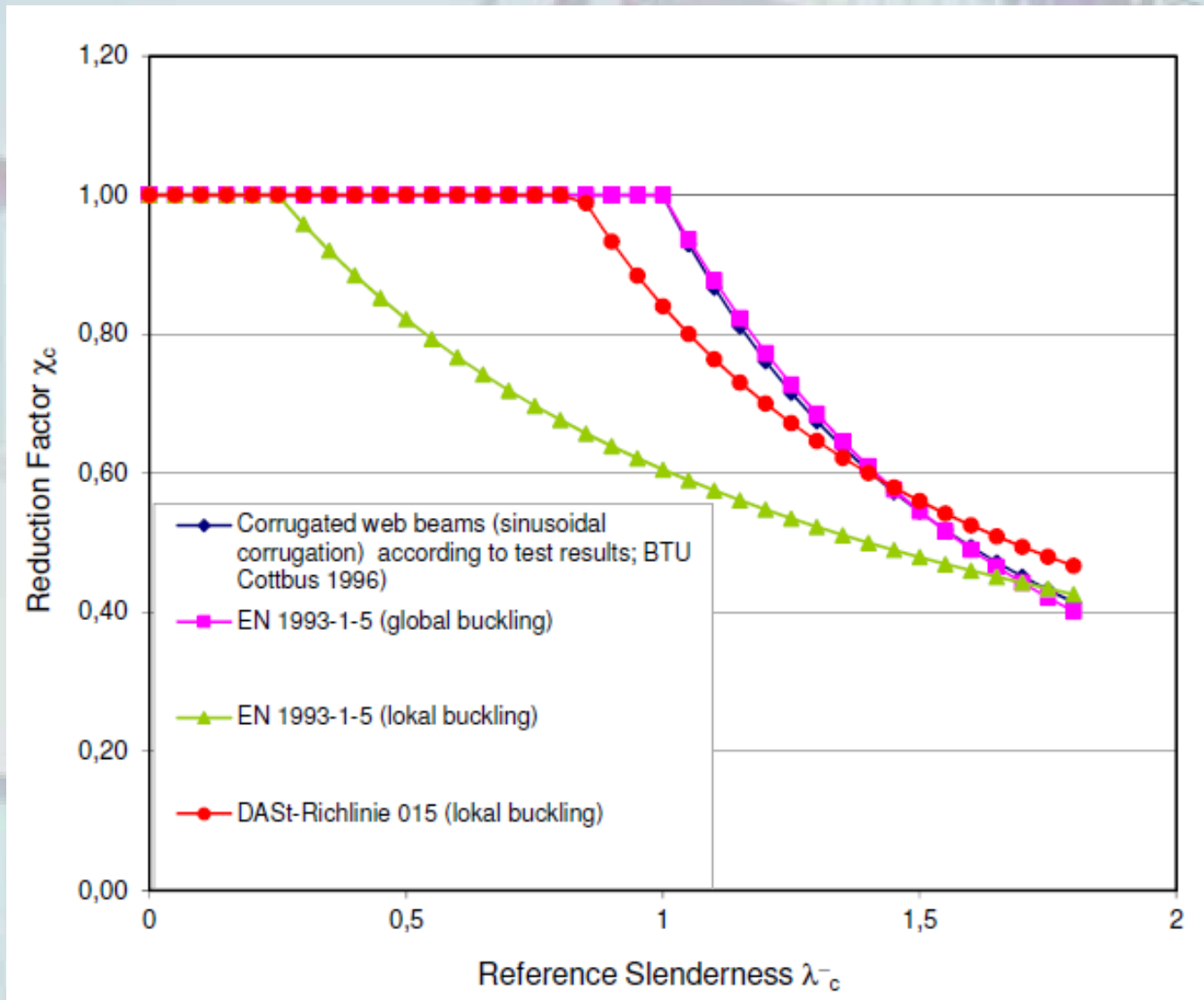


EUROCODE EN 1993-1-5
ANNEX D

+ improvement: neglecting local buckling,
verified by tests for specific sin - geometry



BUCKLING of SIN - WEB





DESIGN PROCEDURE



- **choice of height** (slenderness)

$$h_w \approx L_s/15 \text{ up to } L_s/25$$

- **selection of web thickness** (shearforce)

$$V_d = \gamma_F \cdot V \leq V_{Rd} = V_{Rk} / \gamma_M$$

- **selection of flanges**

(bending moment & axial force)

$$N_{gd} = \gamma_F N \cdot \frac{A_g}{A} \pm \frac{\gamma_F M}{z} \leq N_{g,Rd} = \frac{N_{g,Rk}}{\gamma_M}$$

- **check of serviceability**

(deflection)



DESIGN PROCEDURE



- **choice of height** (slenderness)

$$h_s \approx L_{St}/15 \text{ up to } L_{St}/25$$

- **choice of web thickness** (shearforce)

$$V_d = \gamma_F \cdot V \leq V_{Rd} = V_{Rk} / \gamma_M$$

$f_{y,k}$ 35,5 kN/cm²
Steelgrade S355

h _{web}	WT0					WTA					WTB					WTC									
	t =	1,5	mm	t =	2	mm	t =	2,5	mm	t =	3	mm	t =	1,5	mm	t =	2	mm	t =	2,5	mm	t =	3	mm	
	2w =	155	mm	2w =	155	mm	2w =	155	mm	2w =	155	mm	2w =	155	mm	2w =	155	mm	2w =	155	mm	2w =	155	mm	
	2s =	178	mm	2s =	178	mm	2s =	178	mm	2s =	178	mm	2s =	178	mm	2s =	178	mm	2s =	178	mm	2s =	178	mm	
	2I _y =	4,65	cm ⁴	2I _y =	6,21	cm ⁴	2I _y =	7,77	cm ⁴	2I _y =	10,8	cm ⁴	2I _y =	10,8	cm ⁴	2I _y =	10,8	cm ⁴	2I _y =	10,8	cm ⁴	2I _y =	10,8	cm ⁴	
	Dx =	5,65	kNcm ²	Dx =	13,4	kNcm ²	Dx =	26,2	kNcm ²	Dx =	45,2	kNcm ²	Dx =	45,2	kNcm ²	Dx =	45,2	kNcm ²	Dx =	45,2	kNcm ²	Dx =	45,2	kNcm ²	
	Dz =	6.300	kNcm ²	Dy =	8.414	kNcm ²	Dy =	10.527	kNcm ²	Dy =	14.605	kNcm ²	Dy =	14.605	kNcm ²	Dy =	14.605	kNcm ²	Dy =	14.605	kNcm ²	Dy =	14.605	kNcm ²	
h _{web}	τ _{cr}	τ _{pl}	λ _{quer}	χ _c	V _{rd}	τ _{cr}	τ _{pl}	λ _{quer}	χ _c	V _{rd}	τ _{cr}	τ _{pl}	λ _{quer}	χ _c	V _{rd}	τ _{cr}	τ _{pl}	λ _{quer}	χ _c	V _{rd}	τ _{cr}	τ _{pl}	λ _{quer}	χ _c	V _{rd}
[mm]	[kN/cm ²]	[kN/cm ²]			[kN]	[kN/cm ²]	[kN/cm ²]			[kN]	[kN/cm ²]	[kN/cm ²]			[kN]	[kN/cm ²]	[kN/cm ²]			[kN]	[kN/cm ²]	[kN/cm ²]			
333	212,4	20,5	0,31	1,00	102	245,5	20,5	0,29	1,00	137	274,7	20,5	0,27	1,00	171	335,5	20,5	0,25	1,00	205	335,5	20,5	0,25	1,00	205
500	94,2	20,5	0,47	1,00	154	108,9	20,5	0,43	1,00	205	121,9	20,5	0,41	1,00	256	148,8	20,5	0,37	1,00	307	148,8	20,5	0,37	1,00	307
625	60,3	20,5	0,58	1,00	192	69,7	20,5	0,54	1,00	256	78,0	20,5	0,51	1,00	320	95,2	20,5	0,46	1,00	384	95,2	20,5	0,46	1,00	384
750	41,9	20,5	0,70	1,00	231	48,4	20,5	0,65	1,00	307	54,2	20,5	0,62	1,00	384	66,1	20,5	0,56	1,00	461	66,1	20,5	0,56	1,00	461
1000	23,6	20,5	0,93	1,00	307	27,2	20,5	0,87	1,00	410	30,5	20,5	0,82	1,00	512	37,2	20,5	0,74	1,00	615	37,2	20,5	0,74	1,00	615
1250	15,1	20,5	1,17	0,81	310	17,4	20,5	1,08	0,89	459	19,5	20,5	1,03	0,97	619	23,8	20,5	0,93	1,00	769	23,8	20,5	0,93	1,00	769
1500	10,5	20,5	1,40	0,61	281	12,1	20,5	1,30	0,68	420	13,5	20,5	1,23	0,74	572	16,5	20,5	1,11	0,86	795	16,5	20,5	1,11	0,86	795

Special Web on request



DESIGN PROCEDURE



- **choice of height** (Slenderness)

$$h_s \approx L_{St}/15 \text{ bis } L_{St}/25$$

- **choice of web thickness** (Shearforce)

$$V_d = \gamma_F \cdot V \leq V_{Rd} = V_{Rk}/\gamma_M$$

- **choice of flanges**

(bending moment & axial force)

$$N_{gd} = \gamma_F N \cdot \frac{A_g}{A} \pm \frac{\gamma_F M}{z} \leq N_{g,Rd} = \frac{N_{g,Rk}}{\gamma_M}$$



DESIGN PROCEDURE



$f_{yk} = 355 \text{ N/mm}^2$		Considering Distribution of Normal forces $k_c = 1,00$ (EN1993-1-1, Table 6.6)												$\gamma_M = 1,00$	
Dimensions of Flange		TENSION	PRESSURE												
$b \times t$	A	N_{Rd}	c_{lim}	$N_{Rd} \text{ [kN]}$											c_{max}
[mm]	[cm ²]	[kN]	[m]	Distance of Lateral Support [m]											[m]
				3,00	4,00	5,00	6,00	8,00	10,00	12,00	15,00	18,00	21,00	24,00	
160 x 6	9,60	341	1,76	200	150	120	100	75	60						11,55
180 x 6	10,80	383	1,99	254	190	152	127	95	76	63					12,99
200 x 6	12,00	426	2,21	313	235	188	157	117	94	78					14,43
160 x 8	12,80	454	1,76	267	200	160	134	100	80						11,55
180 x 8	14,40	511	1,99	338	254	203	169	127	101	85					12,99
200 x 8	16,00	568	2,21	418	313	251	209	157	125	104					14,43
220 x 8	17,60	625	2,43	505	379	303	253	189	152	126	101				15,88
200 x 10	20,00	710	2,21	522	392	313	261	196	157	131					14,43
220 x 10	22,00	781	2,43	632	474	379	316	237	189	158	126				15,88
250 x 10	25,00	888	2,76	816	612	489	408	306	245	204	163	136			18,04
200 x 12	24,00	852	2,21	626	470	376	313	235	188	157					14,43
220 x 12	26,40	937	2,43	758	568	455	379	284	227	189	152				15,88
250 x 12	30,00	1065	2,76	979	734	587	489	367	294	245	196	163			18,04
300 x 12	36,00	1278	3,31	1278	1057	846	705	529	423	352	282	235	201		21,65
220 x 15	33,00	1172	2,43	947	711	568	474	355	284	237	189				15,88
250 x 15	37,50	1331	2,76	1223	918	734	612	459	367	306	245	204			18,04
300 x 15	45,00	1598	3,31	1598	1321	1057	881	651	529	440	352	294	252		21,65
350 x 15	52,50	1864	3,86	1864	1799	1439	1199	899	719	600	480	400	343	300	25,26
250 x 20	50,00	1775	2,76	1631	1223	979	816	612	489	408	326	272			18,04
300 x 20	60,00	2130	3,31	2130	1762	1409	1175	881	705	587	470	392	336		21,65
350 x 20	70,00	2485	3,86	2485	2398	1918	1599	1199	959	799	639	533	457	400	25,26
400 x 20	80,00	2840	4,41	2840	2840	2506	2088	1566	1253	1044	835	696	597	522	28,87
450 x 20	90,00	3195	4,96	3195	3195	3171	2643	1982	1586	1321	1057	881	755	661	32,48
300 x 25	75,00	2663	3,31	2663	2202	1762	1468	1101	881	734	587	489	419		21,65
350 x 25	87,50	3106	3,86	3106	2998	2398	1998	1499	1199	999	799	666	571	500	25,26



DESIGN PROCEDURE



- **choice of height** (Slenderness)

$$h_s \approx L_{St}/15 \text{ bis } L_{St}/25$$

- **choice of web thickness** (Shearforce)

$$V_d = \gamma_F \cdot V \leq V_{Rd} = V_{Rk}/\gamma_M$$

- **choice of flanges**

(bending moment & axial force)

$$N_{gd} = \gamma_F N \cdot \frac{A_g}{A} \pm \frac{\gamma_F M}{z} \leq N_{g,Rd} = \frac{N_{g,Rk}}{\gamma_M}$$

- **serviceability**

(deflection)



SECTION PROPERTIES



Dimensions			weight/m						Cross Section Values						S235			S355				
b _g x t _g mm	H mm	U m ² /m	WTD kg/m	WTA kg/m	WTB kg/m	WTC kg/m	WTD kg/m	WTE kg/m	WTF kg/m	Z A _g cm ²	I _y cm ⁴	i _y cm	I _z cm ⁴	i _z cm	I _t cm ⁴	I _w cm ⁴	C _{lim} cm	N _{Rk} kN	M _{Rk} kNm	C _{lim} cm	N _{Rk} kN	M _{Rk} kNm
160 x 6	1012	3,06	29,2	33,9	38,6	43,3	52,8	62,2	71,8	19,2	48.500	50,31	410	4,62	2,8	1.036.000	217	451	227	217	602	343
180 x 6	1012	3,14	31,1	35,8	40,5	45,2	54,6	64,1	73,5	21,60	54.500	50,28	580	5,18	3,1	1.476.000	245	508	255	245	767	386
200 x 6	1012	3,22	33,0	37,7	42,4	47,1	56,5	65,9	75,4	24,00	60.700	50,29	800	5,77	3,4	2.024.000	277	564	284	277	852	429
160 x 8	1016	3,07	34,2	38,9	43,6	48,4	57,8	67,2	76,8	25,6	65.000	50,39	550	4,64	6,0	1.387.000	228	602	303	228	909	458
180 x 8	1016	3,15	36,7	41,4	46,2	50,9	60,3	69,7	79,1	28,80	73.200	50,41	780	5,20	6,7	1.975.000	244	677	341	244	1.022	515
200 x 8	1016	3,23	39,3	44,0	48,7	53,4	62,8	72,2	81,6	32,00	81.300	50,40	1.070	5,78	7,3	2.710.000	277	752	379	277	1.136	573
220 x 8	1016	3,31	41,8	46,5	51,2	55,9	65,3	74,7	84,2	35,20	89.400	50,40	1.420	6,35	8,0	3.606.000	288	827	417	288	1.250	630
200 x 10	1020	3,24	45,5	50,2	55,0	59,7	69,1	78,5	87,9	40,0	102.000	50,50	1.330	5,77	13,9	3.400.000	277	940	475	277	1.420	717
220 x 10	1020	3,32	48,7	53,4	58,1	62,8	72,2	81,6	91,1	44,00	112.200	50,50	1.770	6,34	15,2	4.526.000	288	1.034	522	288	1.562	789
250 x 10																					1.775	896
200 x 12																					1.704	862
220 x 12																					1.874	948
250 x 12																					2.130	1.078
300 x 12																					2.556	1.293
220 x 15																					2.343	1.189
250 x 15																					2.663	1.351
300 x 15																					3.195	1.621
350 x 15																					3.728	1.892
250 x 20																					3.550	1.811
300 x 20																					4.260	2.173
350 x 20	1040	3,88								40,0	369.000	51,00	14.230	10,10	167,2	36.193.000	474	3.230	1.678	474	4.970	2.535
400 x 20	1040	4,08	139,7	144,4	149,2	153,9	153,3	172,7	182,1	50,0	416.200	51,00	21.330	11,55	213,9	55.488.000	542	3.760	1.918	542	5.680	2.897
300 x 25	1050	3,70	131,9	136,6	141,3	146,0	155,4	164,9	174,3	50,0	394.000	51,25	11.250	8,66	313,0	29.549.000	407	3.525	1.807	407	5.325	2.729
350 x 25	1050	3,80	151,5	156,2	160,9	165,6	175,1	184,5	193,9	75,0	459.500	51,25	17.860	10,70	365,1	46.922.000	474	4.113	2.108	474	6.213	3.184
400 x 25	1050	4,10	171,1	175,8	180,6	185,3	194,7	204,1	213,5	200,0	525.300	51,25	26.670	11,55	417,2	70.042.000	542	4.700	2.409	542	7.100	3.639
430 x 25	1050	4,22	182,9	187,6	192,3	197,0	206,5	215,9	225,3	215,0	564.700	51,25	33.130	12,41	448,4	87.013.000	585	5.053	2.589	585	7.633	3.912
450 x 25	1050	4,30	190,8	195,5	200,2	204,9	214,3	223,7	233,1	225,0	591.000	51,25	37.970	12,89	469,3	99.727.000	628	5.288	2.710	628	7.988	4.094
350 x 30	1060	3,92	179,0	183,7	188,4	193,1	202,5	212,0	221,4	210,0	557.000	51,50	21.440	10,70	630,5	56.858.000	474	4.935	2.542	474	7.455	3.839
400 x 30	1060	4,12	202,5	207,2	212,0	216,7	226,1	235,5	244,9	240,0	636.500	51,50	32.000	11,55	720,5	84.872.000	542	5.640	2.905	542	8.520	4.388
430 x 30	1060	4,24	216,7	221,4	226,1	230,8	240,2	249,6	259,1	258,0	684.300	51,50	39.750	12,41	774,5	105.436.000	585	6.063	3.122	585	9.159	4.717
450 x 30	1060	4,32	226,1	230,8	235,5	240,2	249,6	259,1	268,5	270,0	716.100	51,50	45.560	12,89	810,5	120.843.000	628	6.345	3.268	628	9.585	4.936

Technical Documentation
→ www.zeman-stahl.com



COLUMN DESIGN



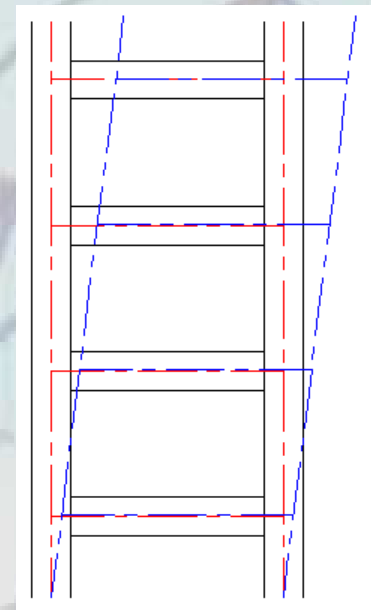
Any standard gives rules for the determination of the critical buckling load of frame- or lattice columns:

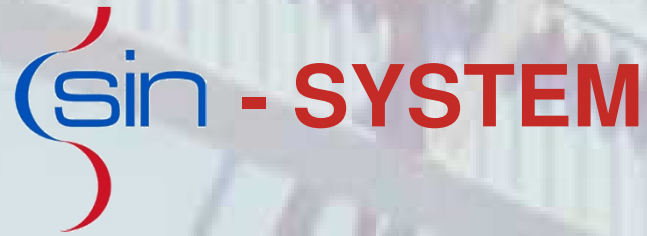
$$N_{ki} = \frac{1}{\frac{l^2}{\pi^2(EI)_d} + \frac{1}{S_d^*}}$$

$$N_{ki} = \frac{1}{\frac{l^2 A}{I} \cdot \frac{1}{\pi^2 EA} + \frac{\pi^2 EA}{GA_Q} \cdot \frac{1}{\pi^2 EA}} = \frac{\pi^2 EA}{\frac{l^2 A}{I} + \frac{\pi^2 EA}{GA_Q}} = \frac{\pi^2 EA}{\lambda_y^2 + \lambda_1^2} = \frac{\pi^2 EA}{\lambda_{ki}^2}$$

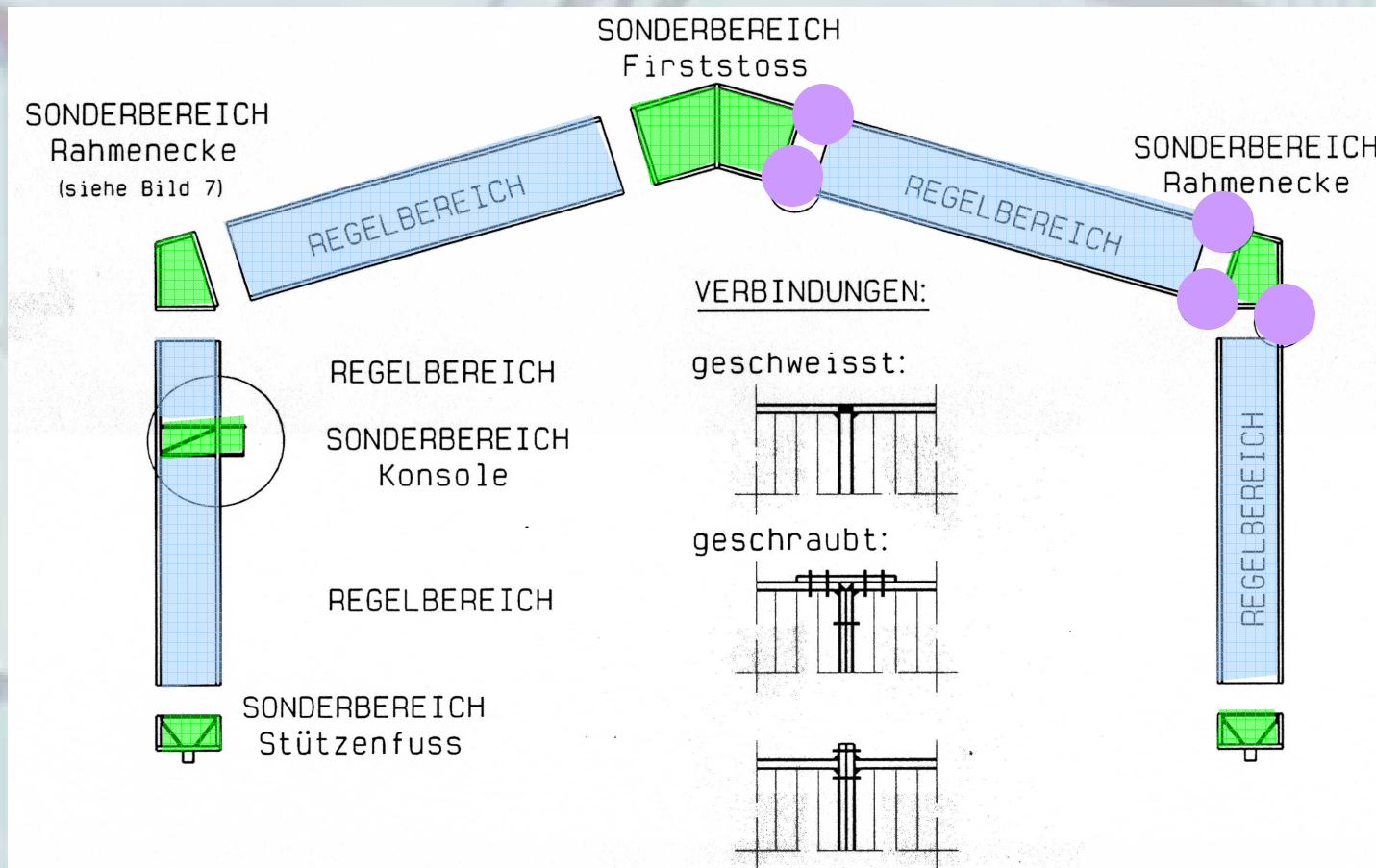
$$\lambda_1^2 = \frac{\pi^2 \cdot E \cdot A}{G_s \cdot t_s \cdot h_s} = \frac{\pi^2 \cdot E \cdot A}{G_s \cdot A_Q} = 25,9 \cdot \frac{A}{A_Q} \quad \lambda_y = \sqrt{\frac{l^2 A}{I}} = \frac{l}{\sqrt{\frac{I}{A}}} = \frac{l}{i_y} = \frac{s_{ky}}{i_y}$$

$$\lambda_{kd} = \sqrt{\lambda_y^2 + \lambda_1^2}$$





Standard Parts + Special Parts + Connections





„SIMPLE“ HANGAR



20 m span
9 m height (eaves)

Columns: WTA 750 - 250x15
beams: WTA 750 - 250x12

Girak, Korneuburg

1991



„SIMPLE“ HANGAR



OMV Einstellhalle

2014



WAREHOUSES & SHOPPING CENTERS



Haringsee



WEATHER RESISTANT



galvanized sin beams for outside usage



Stefanitsch



(HEAVY) INDUSTRIAL PLANTS



Huta Baildon, Kattowice (PL)



MORE THAN HANGARS



Main Railway Station Salzburg



COMBINATION WITH CONVENTIONAL CONSTRUCTION



Main Railway Station Salzburg



DETAILING



VA - Stahl,
Warmbundhalle

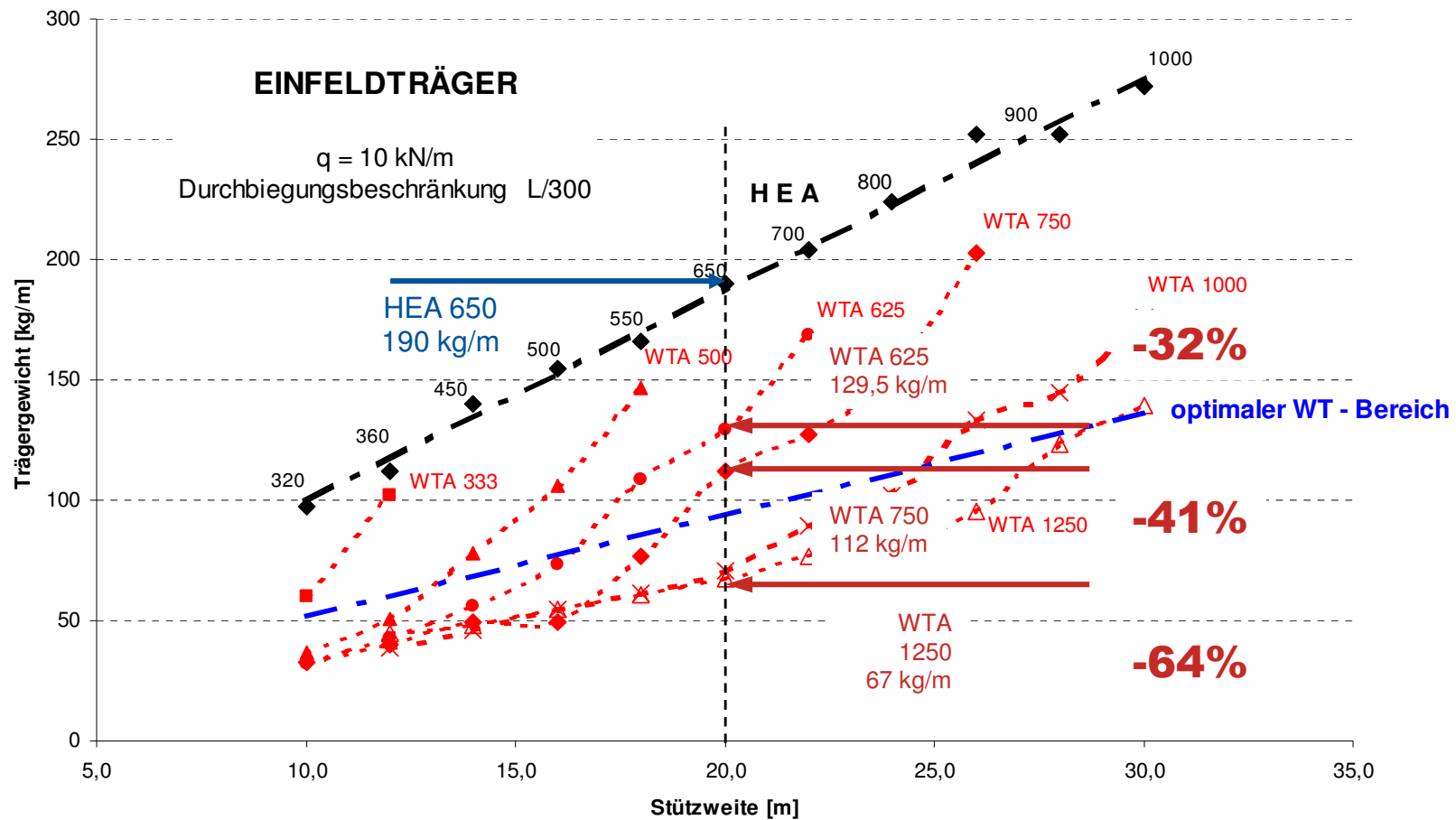


ADVANTAGES OF SIN



compared with

- **hot rolled profiles**
 - **saving of weight**
 - **height > stiffness**
 - ...





ADVANTAGES OF SIN

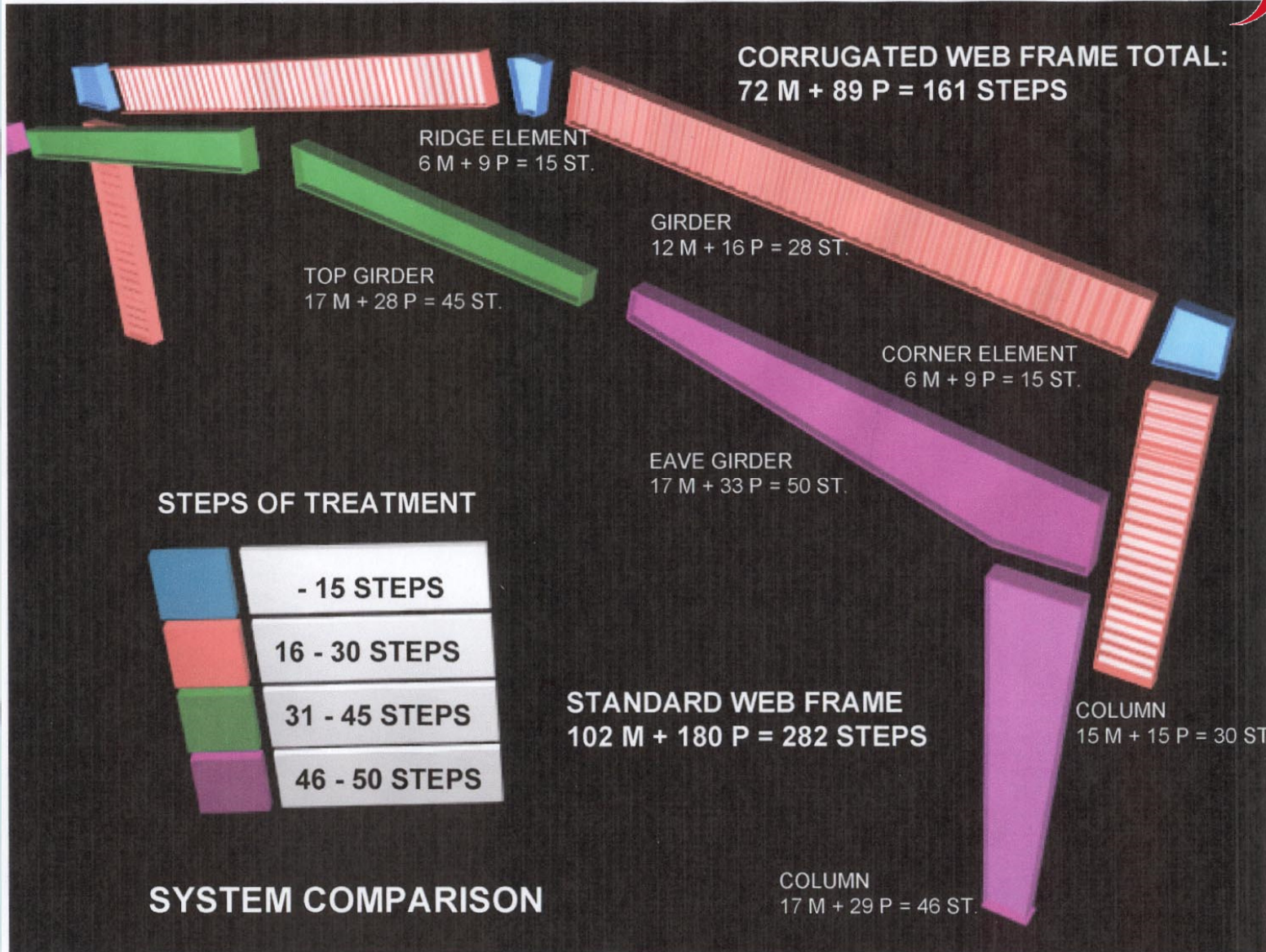


compared with

- **hot rolled profiles**
 - saving of weight
 - heigher stiffness
 - ...
- **lattice girders**
 - efficient, automatic fabrication
 - ...
- **welded profile**
 - efficient, automatic fabrication
 - ...



ADVANTAGES





FABRICATION



to be continued ...

visit us in our box