

## Pantex Lattice Girders





Experiments concerning the load-bearing capacity of lattice girders. Institute for Material Testing, Bureau for Civil Engineering, Technical University Munich.

### Field of application

Pantex Lattice Girders have been developed for the special demands in the field of tunneling. The Pantex System has been extensively tested and successfully used for numerous tunnel projects throughout the world. Contrary to standard steel sections (solid-web girders, irrespective of the shape), Pantex Lattice Girders are entirely integrated in the shotcrete lining.



Cross-sectional view of a Pantex Lattice Girder integrated in shotcrete as performed on-site

Thereby, the reinforced lining forms a homogeneous composite structure without unconsolidated areas. Porous zones and shotcrete spray shadows can be avoided. The overall result is a tunnel lining that significantly reduces ground deformations and prevents the ingress of water.

Pantex Lattice Girders ensure an immediate support in the excavation area. The load-bearing characteristics of Pantex Lattice Girders have been proven

in terms of testing procedures, examining the significant static load conditions. These experiments have confirmed the stability and high load-bearing capacity even when not bonded into the shotcrete layer. This is an important criterion for immediate ground support, particularly during the curing time of the shotcrete.

### Integral part of the shotcrete lining reinforcement

Pantex Lattice Girders exhibit an excellent interconnection with the shotcrete layer. The quality of the bond between the shotcrete and the Pantex Lattice Girders is essentially determined by the mechanical properties of the shotcrete (compressive and tensile strength) and the lattice girder

geometry. The excellent interlocking of Pantex Lattice Girders with the shotcrete has been determined by several pull-out tests in terms of characteristic curves. These consolidated findings allow to include the Pantex Lattice Girders into the design of the shotcrete layer according to the reinforced concrete concept.

# Specifications Pantex Lattice Girders

## Bars, Stiffeners

All load-bearing elements are produced according to the particular demands in tunneling:

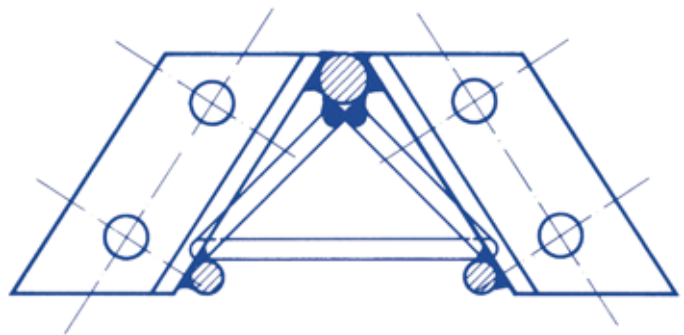
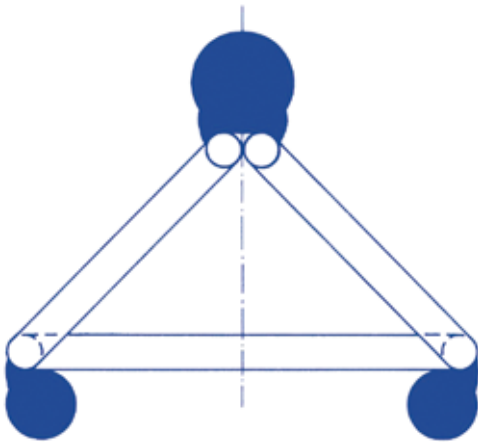
- High strength
- Great deformability
- Well suited for welding
- Steel grade: Reinforcing or construction steel BSt 500 according to DIN 488-1

## Connections

- **Flat steel** or **angle steel** St 37-2 or St 52-3 according to DIN 17100, depending on the girder type
- **Bolts** are provided in matched quality (e.g. 8.8 according to DIN 267-3)

## Quality Control

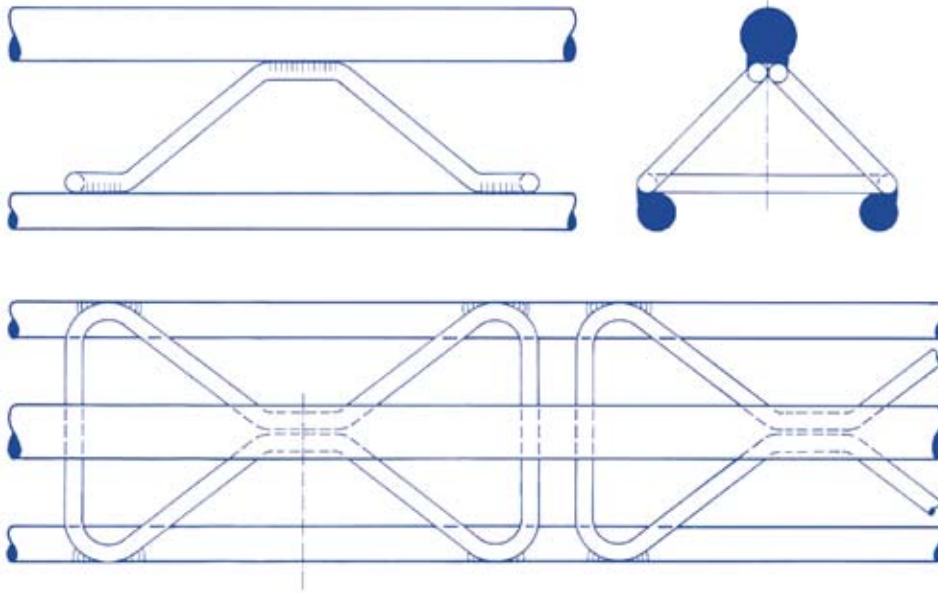
All quality features are defined according to the theory of quality control as 5%-quantile of the basic population considering a statistical probability of  $W = 0,9$ . Materials and manufacturing of Pantex Lattice Girders (particularly the welding work) are continuously controlled both by self-monitoring and external quality control.



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## Advantages Pantex Lattice Girders

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### Main advantages for the use of Pantex Lattice Girders

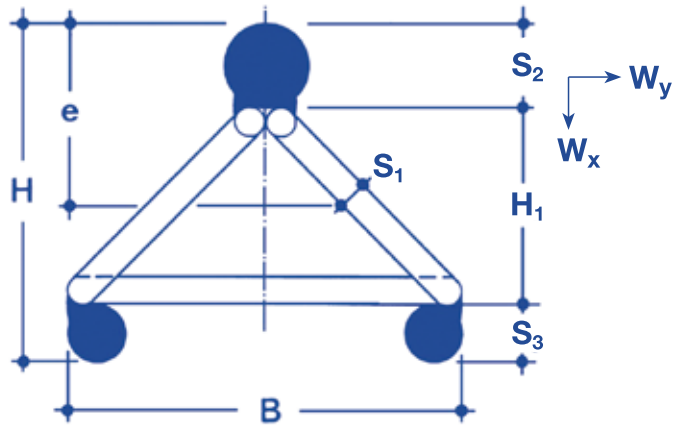
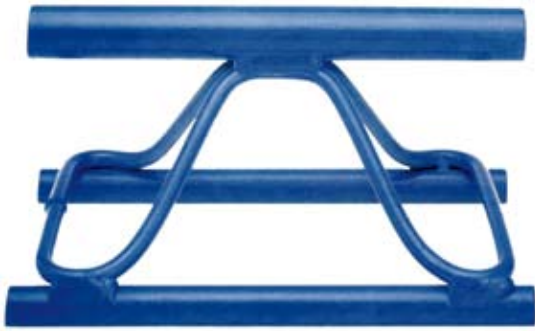
- Immediate support in the excavation area
- Utilization as a template when applying shotcrete
- Easy and quick assembling, simple handling
- Optimum bond and interconnection with the shotcrete lining
- Simple adjustment and shaping to the excavation geometry
- Optimum bearing for spiles and lagging boards
- Spiles can be installed both above or through Pantex Lattice Girders



## Pantex Lattice Girders / 3 Bars

Three bars, aligned with stiffeners, are assembled to form a girder. Thereby, the single bar can, depending on the requirements, either be arranged on the inner or outer side relative to the curvature fitting the specific excavation geometry. The stiffeners (also known

as “spiders”) reduce the local buckling lengths of the bars and provide, besides a high normal and bending moment resistance, an assured transfer of the normal forces even before the shotcrete has been applied.



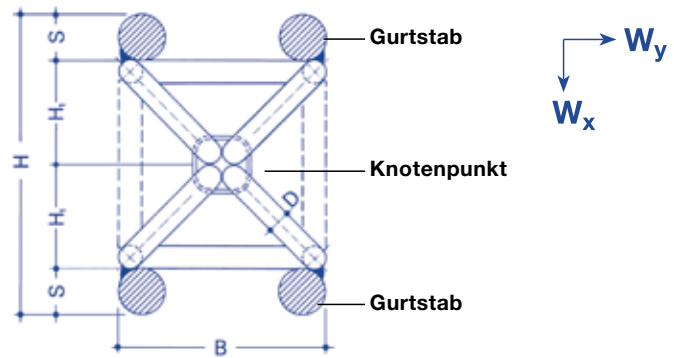
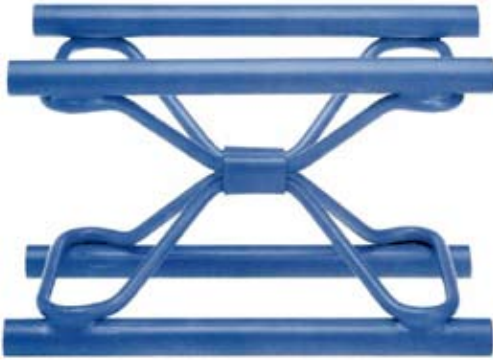
Type (H <sub>1</sub> )	S <sub>1</sub> [mm]	S <sub>2</sub> [mm]	S <sub>3</sub> [mm]	Weight [kg/m]	H [mm]	B [mm]	e [cm]	A <sup>1)</sup> [cm <sup>2</sup> ]	J <sub>x</sub> [cm <sup>4</sup> ]	W <sub>x</sub> [cm <sup>3</sup> ]	J <sub>y</sub> [cm <sup>4</sup> ]	W <sub>y</sub> [cm <sup>3</sup> ]
50	10	26	18	10	94	100	4,82	10,4	138	29	89	18
		30	20	12,3	100		5,03	13,35	193	38	106	21
		32	22	14,3	124		6,31	15,64	375	60	272	39
70	10	26	18	10,2	114	140	5,79	10,4	223	39	192	27
		30	20	12,5	120		5,97	13,35	306	51	232	33
		32	22	14,3	124		6,31	15,64	375	60	272	39
		34	26	17,5	130		7,09	19,7	501	71	356	51
95	10	26	18	10,7	139	180	7,01	10,4	359	51	337	37
		26	20	11,7	141		7,69	11,59	405	53	406	45
		30	20	13,1	145		7,14	13,35	485	66	407	45
		32	22	14,9	149		7,53	15,64	589	78	482	54
		34	26	18,2	155		8,44	19,7	774	92	641	71
115	12	26	18	11,7	159	220	7,99	10,4	491	61	521	47
		30	20	14,1	165		8,09	13,35	658	78	634	58
		32	22	15,9	169		8,50	15,64	795	94	752	68
		34	26	19,2	175		9,52	19,7	1040	109	1010	92
130	12	26	18	11,7	174	220	8,72	10,4	603	69	521	47
		30	20	14,1	180		8,79	13,35	805	87	634	58
		32	22	15,9	184		9,23	15,64	971	105	752	68
		34	26	19,2	190		10,33	19,7	1264	122	1010	92

1) Cross-sectional area of the bars

## Pantex Lattice Girders / 4 Bars

Four bars, aligned with stiffeners, are assembled to form a girder. Due to the design of the 4-bar girder, an adjustment to fit the specific excavation geometry can easily be accomplished. The stiffeners reduce the local buckling lengths of the bars and provide, besides

a high normal and bending moment resistance, an assured transfer of the normal forces even before the shotcrete has been applied.



Type (H1)	D [mm]	S [mm]	Weight [kg/m]	H [mm]	B [mm]	A <sup>1)</sup> [cm <sup>2</sup> ]	Jx [cm <sup>4</sup> ]	Wx [cm <sup>3</sup> ]	Jy [cm <sup>4</sup> ]	Wy [cm <sup>3</sup> ]
100	10	18	11,33	136	100	10,20	356	52	173	35
		20	13,21	140		12,56	456	65	204	41
		22	15,22	144		15,20	570	79	234	47
		26	19,98	152		21,24	851	112	299	59
		30	25,53	160		28,28	1210	151	302	72
140	10	18	11,72	176	140	10,20	637	72	381	54
		20	13,60	180		12,56	807	90	456	65
		22	15,64	184		15,20	1002	109	534	76
		26	20,40	192		21,24	1472	153	699	100
		30	25,92	200		28,28	2059	206	871	124
180	10	18	12,67	216	180	10,20	999	93	670	74
		20	14,55	220		12,56	1260	115	807	90
		22	16,59	224		15,20	1555	139	953	106
		26	21,35	232		21,24	2262	195	1268	141
		30	26,87	240		28,28	3133	261	1606	178

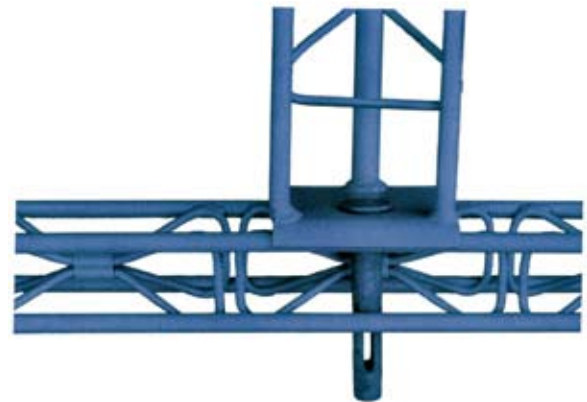
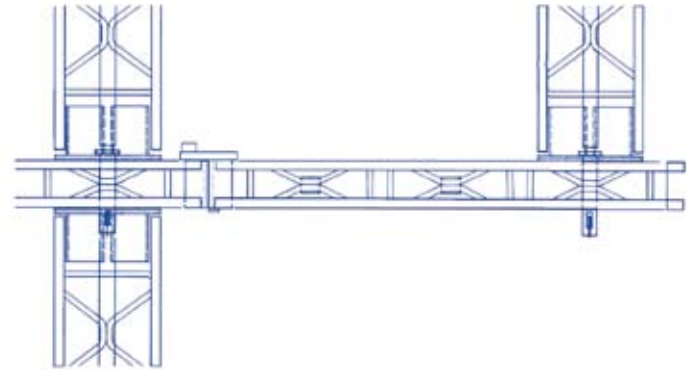
1) Cross-sectional area of the bars

## Pantex Lattice Girders / Wallplate Beams

4-bar-girders are also used as longitudinal wall plates for heading advances. They serve as bearing and template for the arch assembly. At the same time, they can be considered as statically effective

reinforcement for the base beams. The frontal connection is bending resistant.

Length	Height	Width	Rod Diameter	Stiffeners Diameter
[mm]	[mm]	[mm]	[mm]	[mm]
500	100	136	18	10
750	100	136	18	10
1000	100	136	18	10
1250	100	140	20	10
1500	100	140	20	10
1750	100	140	20	10
2000	100	140	20	10



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