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EN 15048
EN 14399-4/6
EN 14399-3/6

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Technical sheet



The publication of non-preloaded bolting standards for steel construction (EN 15048) as well as the execution standards for steel structures (Eurocode 3 EN 1090-1 and 2) has changed the use of bolts in metal construction.

The harmonized standards (published in the Official Journal of the European Union) made the CE label mandatory for structural bolting. Structural design notes must be formulated according to the Eurocode in conformity with Annex A of EN 1090-1.

Types

There are three bolt combinations important in steel construction. The combinations are indicated with HV, which is subjected to EN14399-4/6, HR, defined by EN 14399-3/6 and SB, defined by EN 15048.

HV and HR

The designations HV and HR apply to pre-loaded bolt sets (class 10.9). The abbreviation HV comes from the German term 'Hochfest Vorgespannt'. The term HR stands for 'High Resistance'. Both bolts are used in both static and predominantly dynamic steel constructions. By pre-tensioning the bolts at the right tightening torque, a strong connection is made.

HV and HR hex bolts have a larger hexagonal width than standard bolts and therefore have a larger bearing surface under the head to better distribute the tension on the bolts. The defined coefficient of friction makes it possible to pre-tension them.

Where joints have not been calculated with the slip factor included, pre-loading is not required. However, it is usual to pre-load joints in order to reduce the slack, increase the resistance to dynamic loads and limit the deformation of the whole structure.

SB

SB-sets are designed for static steel structure joints where pre-loading is not necessary. SB designation applies to non-preloaded steel structure connections. SB stands for 'Structure Bolting'. Non-preloaded connections can also be executed with HV/HR bolts according to EN 14399.

Corrosion resistance

pgb Hot-dip galvanized HV, HR, and SB bolts are galvanized according to ISO 10684 with a minimum of 50 microns thickness and have an excellent corrosion resistance. SB bolts are also available zinc plated.

Use

HV and HR bolted connections can be used in both predominantly static constructions and predominantly dynamic constructions. Examples of predominantly static structures are halls, steel skeleton buildings and scaffolding where no high loads are required. These connections are therefore mainly loaded on shear.

Predominantly dynamic constructions include cranes, rails, bridges, pylons or wind turbines. These constructions are subjected to greater forces and therefore the bolt connection must be fully pre-tensioned. The connection is then not loaded on shear, but on tensile force in the bolted connection.

Contents

HV-sets

| | |
|-----------------------------------|----|
| HV combinations | 4 |
| Clamping capacity HV-sets | 6 |
| Steel structure thickness HV-sets | 8 |
| Tightening torque HV-sets | 9 |
| | 10 |

HR-sets

| | |
|-----------------------------------|----|
| HR combinations | 12 |
| Clamping capacity HR-sets | 14 |
| Steel structure thickness HR-sets | 16 |
| Tightening torque HR-bouten | 17 |
| | 18 |

SB-sets

| | |
|---------------------------|----|
| SB combinations | 20 |
| Clamping capacity SB-sets | 22 |
| | 24 |

HV-sets

Standards

The EN 14399 standard has been developed for high strength pre-loaded fasteners. Parts 1 and 2 of this standard describe the requirements and the process to get the CE marking. The screws, nuts and washers composing the HV sets can be found in parts 4 and 6 of this standard.

In compliance with the European standard, hot dip galvanized HV nuts are always treated with a special molybdenum disulphide lubricant giving this characteristic black color.

An HV set consists of the following elements:

- 1 HV 10.9 hexagon head screw, hot-dip galvanized, in accordance with EN 14399-4
- 1 hexagonal nut HV 10, hot-dip galvanized, in accordance with standard EN 14399-4
- 2 HV 300-370 HV washers, hot-dip galvanized, in accordance with EN 14399-6

HV bolting assemblies are relevant in the field of metal construction (halls, bridges, wind turbines, pylons, etc.).

In the absence of specific indication, HV bolts meet class K1.

Identification

In order to allow a clear identification of the HV sets, each element bears a marking to identify the product and limit the risk of error. In addition, the indication of the manufacturing batch number guarantees traceability before and after assembly. The marking must therefore always remain visible. When mounting the washers and nuts, it is mandatory to ensure that the face bearing the marking is facing outward.



- HV designation
- Resistance class 10.9
- Manufacturer's symbol 'PGB'
- Batch number (eg 15)



- HV designation
- Resistance class 10Z
- Manufacturer's symbol 'PGB'
- Batch number (eg 15)



- Designation H
- Manufacturer's symbol 'PGB'
- Batch number (eg 15)

Standard range

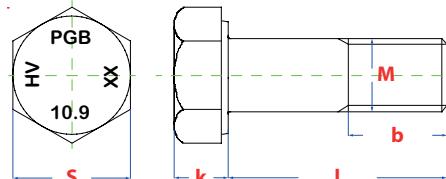
| HV 10.9 bolt, EN 14399-4 | HV 10 nut, EN 14399-4 | HV washer, EN 14399-6 |
|--------------------------|-------------------------|-----------------------|
| M12 x 30 – 120 | M12 | M12 |
| M16 x 35 – 150 | M16 | M16 |
| M20 x 50 – 170 | M20 | M20 |
| M24 x 55 – 160 | M24 | M24 |
| M27 x 60 – 160 | M27 | M27 |
| M30 x 80 – 180 | M30 | M30 |
| M36 x 90 – 200 | M36 | M36 |

Screws, nuts and washers are sold separately.



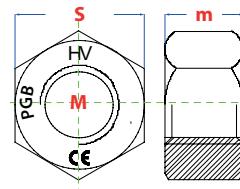
HV combinations

HV hexagonal head screw - 10.9 – Hot dip galvanized – EN 14399-4



| Size | M12 | M16 | M20 | M24 | M27 | M30 | M36 |
|--------------------|------|-----|-----|-----|-----|-----|-----|
| Socket wrench (S) | 22 | 27 | 32 | 41 | 46 | 50 | 60 |
| Pitch (P) | 1,75 | 2,0 | 2,5 | 3,0 | 3,0 | 3,5 | 4,0 |
| Head thickness (k) | 8 | 10 | 13 | 15 | 17 | 19 | 23 |
| Thread length (b) | 23 | 28 | 33 | 39 | 41 | 44 | 52 |

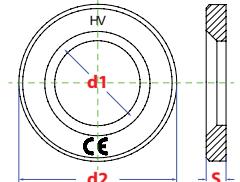
HV nut – classe |10| – Hot dip galvanized + lubricant (MoS2) black – EN 14399-4



| Size | M12 | M16 | M20 | M24 | M27 | M30 | M36 |
|-------------------|-----|-----|-----|-----|-----|-----|-----|
| Socket wrench (S) | 22 | 27 | 32 | 41 | 46 | 50 | 60 |
| Height (m) | 10 | 13 | 16 | 19 | 22 | 24 | 29 |

MoS2 is a common dry or powder lubricant and has a black graphite colour. This explains why the nuts have a black colour after adding this lubricant.

HV washer – 300-370 hv – Hot dip galvanized – EN 14399-6



| Size | M12 | M16 | M20 | M24 | M27 | M30 | M36 |
|---------------------|-----|-----|-----|-----|-----|-----|-----|
| Inner diameter (d1) | 13 | 17 | 21 | 25 | 28 | 31 | 37 |
| Outer diameter (d2) | 24 | 30 | 37 | 44 | 50 | 56 | 66 |
| Thickness (S) | 3 | 4 | 4 | 4 | 5 | 5 | 6 |

Choice of length according to clamping capacity

Important remarks about clamping capacity

As the thread length of HV bolts is relatively short, a particular attention should be paid to the choice of length according to clamping capacity. If an HV bolt is too long, the body (non-threaded part) of the bolt may exceed the thickness of the steel structure thickness, preventing the required pre-stressing force to be applied. Conversely, in case the bolt is too short, the available thread length is insufficient to effectively resume the pre-stressing force.

Therefore, the following conditions must be fulfilled:

$$(l_{g_{\max}} + 2P) < \sum t < (l_{\min} - P - m_{\max})$$

- $l_{g_{\max}}$ = maximum body length
- P = screw pitch
- $\sum t$ = clamping capacity
- m_{\max} = maximum nut height
- l_{\min} = nominal screw length

In other words:

$$(body\ length + 2\ pitch) < clamping\ capacity < (nominal\ length - 1\ pitch - 1\ nut\ height)$$

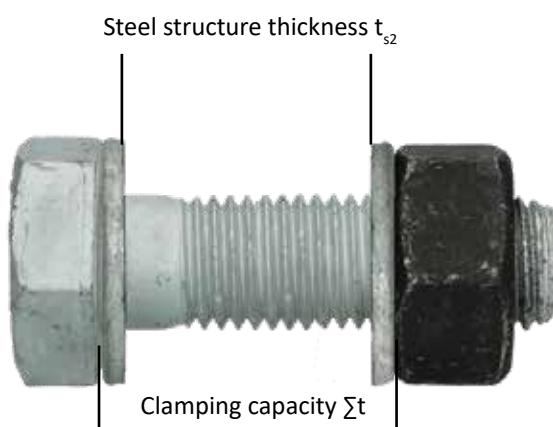
The values indicated in the table on the next page $\sum t_{\min}$ and $\sum t_{\max}$ are within this perimeter. The values for $\sum t_{\max}$ are fixed so that the screw protrudes 1 pitch from the free face of the nut.

Clamping capacity with HV-sets

The definition of the clamping capacity according to EN 14399-4 includes two washers. We must therefore distinguish the tightening capacity of the bolt and the thickness of the steel structure.

Clamping capacity is the distance between the head of the screw and the nut.

Steel structure thickness is the distance between the 2 washers. According to EN 1090-2, to compensate the clamping length, up to three washers of a total thickness not exceeding 12 mm can be installed on the end which is not turned.



Clamping capacity HV-sets

Clamping capacity Σt

| Size | M12 | | M16 | | M20 | | M24 | | M27 | | M30 | | M36 | |
|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| L | min | max |
| 30 | 11 | 16 | | | | | | | | | | | | |
| 35 | 16 | 21 | 12 | 17 | | | | | | | | | | |
| 40 | 21 | 26 | 17 | 22 | | | | | | | | | | |
| 45 | 26 | 31 | 22 | 27 | | | | | | | | | | |
| 50 | 31 | 36 | 27 | 32 | 23 | 28 | | | | | | | | |
| 55 | 36 | 41 | 32 | 37 | 28 | 33 | 24 | 29 | | | | | | |
| 60 | 41 | 46 | 37 | 42 | 33 | 38 | 29 | 34 | 26 | 31 | | | | |
| 65 | 46 | 51 | 42 | 47 | 38 | 43 | 34 | 39 | 31 | 36 | | | | |
| 70 | 51 | 56 | 47 | 52 | 43 | 48 | 39 | 44 | 36 | 41 | | | | |
| 75 | 56 | 61 | 52 | 57 | 48 | 53 | 44 | 49 | 41 | 46 | | | | |
| 80 | 61 | 66 | 57 | 62 | 53 | 58 | 49 | 54 | 46 | 51 | 44 | 49 | | |
| 85 | 66 | 71 | 62 | 67 | 58 | 63 | 54 | 59 | 51 | 56 | 49 | 54 | | |
| 90 | 71 | 76 | 67 | 72 | 63 | 68 | 59 | 64 | 56 | 61 | 54 | 59 | 48 | 53 |
| 95 | 76 | 81 | 72 | 77 | 68 | 73 | 64 | 69 | 61 | 66 | 59 | 64 | 53 | 58 |
| 100 | 81 | 86 | 77 | 82 | 73 | 78 | 69 | 74 | 66 | 71 | 64 | 69 | 58 | 63 |
| 105 | 86 | 91 | 82 | 87 | 78 | 83 | 74 | 79 | 71 | 76 | 69 | 74 | 63 | 68 |
| 110 | 91 | 96 | 87 | 92 | 83 | 88 | 79 | 84 | 76 | 81 | 74 | 79 | 68 | 73 |
| 115 | 96 | 101 | 92 | 97 | 88 | 93 | 84 | 89 | 81 | 86 | 79 | 84 | 73 | 78 |
| 120 | 101 | 106 | 97 | 102 | 93 | 98 | 89 | 94 | 86 | 91 | 84 | 89 | 78 | 83 |
| 125 | | | 102 | 107 | 98 | 103 | 94 | 99 | 91 | 96 | 89 | 94 | 83 | 88 |
| 130 | | | 107 | 112 | 103 | 108 | 99 | 104 | 96 | 101 | 94 | 99 | 88 | 93 |
| 135 | | | 112 | 117 | 108 | 113 | 104 | 109 | 101 | 106 | 99 | 104 | 93 | 98 |
| 140 | | | 117 | 122 | 113 | 118 | 109 | 114 | 106 | 111 | 104 | 109 | 98 | 103 |
| 145 | | | 122 | 127 | 118 | 123 | 114 | 119 | 111 | 116 | 109 | 114 | 103 | 108 |
| 150 | | | 127 | 132 | 123 | 128 | 119 | 124 | 116 | 121 | 114 | 119 | 108 | 113 |
| 155 | | | | | 128 | 133 | 124 | 129 | 121 | 126 | 119 | 124 | 113 | 118 |
| 160 | | | | | 133 | 138 | 129 | 134 | 126 | 131 | 124 | 129 | 118 | 123 |
| 165 | | | | | 138 | 143 | | | | | 129 | 134 | 123 | 128 |
| 170 | | | | | 143 | 148 | | | | | 134 | 139 | 128 | 133 |
| 175 | | | | | | | | | | | 139 | 144 | 133 | 138 |
| 180 | | | | | | | | | | | 144 | 149 | 138 | 143 |
| 185 | | | | | | | | | | | | 143 | 148 | |
| 190 | | | | | | | | | | | | 148 | 153 | |
| 195 | | | | | | | | | | | | 153 | 158 | |
| 200 | | | | | | | | | | | | 158 | 163 | |

Steel construction thickness HV-sets

Steel construction thickness t_{s2}

| Size | M12 | | M16 | | M20 | | M24 | | M27 | | M30 | | M36 | |
|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| L | min | max |
| 30 | 5 | 10 | | | | | | | | | | | | |
| 35 | 10 | 15 | 4 | 9 | | | | | | | | | | |
| 40 | 15 | 20 | 9 | 14 | | | | | | | | | | |
| 45 | 20 | 25 | 14 | 19 | | | | | | | | | | |
| 50 | 25 | 30 | 19 | 24 | 15 | 20 | | | | | | | | |
| 55 | 30 | 35 | 24 | 29 | 20 | 25 | 16 | 21 | | | | | | |
| 60 | 35 | 40 | 29 | 34 | 25 | 30 | 21 | 26 | 16 | 21 | | | | |
| 65 | 40 | 45 | 34 | 39 | 30 | 35 | 26 | 31 | 21 | 26 | | | | |
| 70 | 45 | 50 | 39 | 44 | 35 | 40 | 31 | 36 | 26 | 31 | | | | |
| 75 | 50 | 55 | 44 | 49 | 40 | 45 | 36 | 41 | 31 | 36 | | | | |
| 80 | 55 | 60 | 49 | 54 | 45 | 50 | 41 | 46 | 36 | 41 | 34 | 39 | | |
| 85 | 60 | 65 | 54 | 59 | 50 | 55 | 46 | 51 | 41 | 46 | 39 | 44 | | |
| 90 | 65 | 70 | 59 | 64 | 55 | 60 | 51 | 56 | 46 | 51 | 44 | 49 | 36 | 41 |
| 95 | 70 | 75 | 64 | 69 | 60 | 65 | 56 | 61 | 51 | 56 | 49 | 54 | 41 | 46 |
| 100 | 75 | 80 | 69 | 74 | 65 | 70 | 61 | 66 | 56 | 61 | 54 | 59 | 46 | 51 |
| 105 | 80 | 85 | 74 | 79 | 70 | 75 | 66 | 71 | 61 | 66 | 59 | 64 | 51 | 56 |
| 110 | 85 | 90 | 79 | 84 | 75 | 80 | 71 | 76 | 66 | 71 | 64 | 69 | 56 | 61 |
| 115 | 90 | 95 | 84 | 89 | 80 | 85 | 76 | 81 | 71 | 76 | 69 | 74 | 61 | 66 |
| 120 | 95 | 100 | 89 | 94 | 85 | 90 | 81 | 86 | 76 | 81 | 74 | 79 | 66 | 71 |
| 125 | | | 94 | 99 | 90 | 95 | 86 | 91 | 81 | 86 | 79 | 84 | 71 | 76 |
| 130 | | | 99 | 104 | 95 | 100 | 91 | 96 | 86 | 91 | 84 | 89 | 76 | 81 |
| 135 | | | 104 | 109 | 100 | 105 | 96 | 101 | 91 | 96 | 89 | 94 | 81 | 86 |
| 140 | | | 109 | 114 | 105 | 110 | 101 | 106 | 96 | 101 | 94 | 99 | 86 | 91 |
| 145 | | | 114 | 119 | 110 | 115 | 106 | 111 | 101 | 106 | 99 | 104 | 91 | 96 |
| 150 | | | 119 | 124 | 115 | 120 | 111 | 116 | 106 | 111 | 104 | 109 | 96 | 101 |
| 155 | | | | | 120 | 125 | 116 | 121 | 111 | 116 | 109 | 114 | 101 | 106 |
| 160 | | | | | 125 | 130 | 121 | 126 | 116 | 121 | 114 | 119 | 106 | 111 |
| 165 | | | | | 130 | 135 | | | | | 119 | 124 | 111 | 116 |
| 170 | | | | | 135 | 140 | | | | | 124 | 129 | 116 | 121 |
| 175 | | | | | | | | | | | 129 | 134 | 121 | 126 |
| 180 | | | | | | | | | | | 134 | 139 | 126 | 131 |
| 185 | | | | | | | | | | | | 131 | 136 | |
| 190 | | | | | | | | | | | | 136 | 141 | |
| 195 | | | | | | | | | | | | 141 | 146 | |
| 200 | | | | | | | | | | | | 146 | 151 | |

Tightening torque HV-sets

Tightening torque for class K1

Combined method (torque + angle)

| | Torque to be applied | Pre-tightening torque | Pre-loading |
|----|----------------------|-----------------------|-------------------|
| | $M_{r,1}$ [Nm] | $M_{r,i}$ [Nm] | $F_{p,c}$ [kN] |
| | | With $K_i = 0,13$ | |
| M | | Class 10.9 | |
| 12 | 92 | 69 | 59 |
| 16 | 229 | 172 | 110 |
| 20 | 446 | 335 | 172 |
| 22 | 607 | 455 | 212 |
| 24 | 771 | 578 | 247 |
| 27 | 1128 | 846 | 321 |
| 30 | 1532 | 1149 | 393 |
| 36 | 2676 | 2007 | 572 |

| Stage 1 according to EN 1090-2 | |
|---|--|
| $M_{r,i} = 0,75 \times M_{r,1}$ | |
| Met $F_{p,c} = 0,7 \times F_{ub} \times A_s$ $M_{r,1} = K_m \times d \times F_{p,c}$ $K = 0,10 \leq K_i \leq 0,16$ | $F_{p,c}$: nominal preload according to EN 1090-2 |

| Stage 2 according to EN 1090-2 | |
|--------------------------------|-------------------------|
| Clamping capacity Σt | Final angle of rotation |
| d = screw diameter | Class 10.9 |
| $\Sigma t < 2d$ | 60° or 1/6 of a turn |
| $2d \leq \Sigma t < 6d$ | 90° or 1/4 of a turn |
| $\Sigma t \geq 6d$ | 120° or 1/3 of a turn |

Tip: Tightening torque on the label

The labels of pgb-fasteners show the recommended torque according to EN 14399 for the HV combinations.



Notes

HR-sets

Standards

The EN 14399 standard has been developed for high strength pre-loaded fasteners. Parts 1 and 2 of this standard describe the requirements and the process to get the "CE" marking. The screws, nuts and washers composing the HR sets can be found in parts 3 and 6 of this standard.

In compliance with the European standard, hot dip galvanized HR nuts are always treated with a special molybdenum disulphide lubricant giving this characteristic black color.

An HR set consists of the following elements:

- 1 HR 10.9 hexagon head screw, hot-dip galvanized, in accordance with EN 14399-3
- 1 hexagonal nut HV 10, hot-dip galvanized, in accordance with standard EN 14399-3
- 2 HV 300-370 HV washers, hot-dip galvanized, in accordance with EN 14399-6

The pgb HR bolts must be pre-tensioned according to the class K2 method in two steps.

Identification

In order to allow a clear identification of the HR sets, each element bears a marking to identify the product and limit the risk of error. In addition, the indication of the manufacturing batch number guarantees traceability before and after assembly. The marking must therefore always remain visible. When mounting the washers and nuts, it is mandatory to ensure that the face bearing the marking is facing outward.



- HR designation
- Resistance class 10.9
- Manufacturer's symbol 'PGB'
- Batch number (eg 11)



- HR designation
- Resistance class '10Z'
- Manufacturer's symbol 'PGB'
- Batch number (eg 07)



- Designation 'H'
- Manufacturer's symbol 'PGB'
- Batch number (eg 15)

Standard range

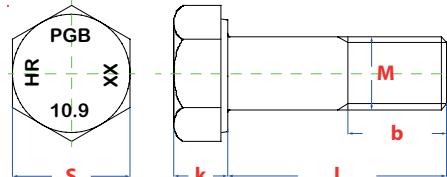
| HR 10.9 bolt, EN 14399-3 | HR 10 nut, EN 14399-3 | HR washer, EN 14399-6 |
|--------------------------|-----------------------|-----------------------|
| M12 x 30 – 90 | M12 | M12 |
| M14 x 30 – 70 | M14 | M14 |
| M16 x 40 – 110 | M16 | M16 |
| M18 x 50 – 100 | M18 | M18 |
| M20 x 45 – 160 | M20 | M20 |
| M22 x 50 – 110 | M22 | M22 |
| M24 x 60 – 280 | M24 | M24 |
| M27 x 70 – 170 | M27 | M27 |
| M30 x 80 – 195 | M30 | M30 |
| M36 x 100 – 200 | M36 | M36 |

HR-combinations are delivered pre-assembled with 2 washers and 1 nut.



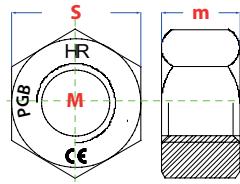
HR combinations

HR hexagonal head screw - 10.9 – Hot dip galvanized – EN 14399-3



| Size | M12 | M14 | M16 | M18 | M20 | M22 | M24 | M27 | M30 | M36 |
|---------------------------------|------|-----|-----|------|------|-----|-----|-----|------|------|
| Socket wrench (S) | 22 | 24 | 27 | 30 | 32 | 36 | 41 | 46 | 50 | 60 |
| Pitch (P) | 1,75 | 2,0 | 2,0 | 2,5 | 2,5 | 2,5 | 3,0 | 3,0 | 3,5 | 4,0 |
| Head thickness (k) | 7,5 | 8,8 | 10 | 11,5 | 12,5 | 14 | 15 | 17 | 18,7 | 22,5 |
| Thread length (b) ≤ 125 | 30 | 34 | 38 | 42 | 46 | 50 | 54 | 60 | 66 | 78 |
| Thread length (b) > 125 ≤ 200 | - | 40 | 44 | 48 | 52 | 56 | 60 | 66 | 72 | 84 |
| Thread length (b) > 200 | - | - | - | - | 65 | 69 | 73 | 79 | 85 | 97 |

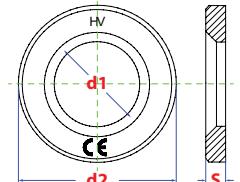
HR nut – classe 10 – Hot dip galvanized + lubricant (MoS2) black – EN 14399-3



| Size | M12 | M14 | M16 | M18 | M20 | M22 | M24 | M27 | M30 | M36 |
|-------------------|------|------|------|-----|-----|-----|------|------|------|-----|
| Socket wrench (S) | 22 | 24 | 27 | 30 | 32 | 36 | 41 | 46 | 50 | 60 |
| Height (m) | 10,8 | 12,8 | 14,8 | 16 | 18 | 20 | 21,5 | 23,8 | 25,6 | 31 |

MoS2 is a common dry or powder lubricant and has a black graphite colour. This explains why the nuts have a black colour after adding this lubricant.

HV washer – 300-370 hv – Hot dip galvanized – EN 14399-6



| Size | M12 | M16 | M18 | M20 | M22 | M24 | M27 | M30 | M36 |
|---------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Inner diameter (d1) | 13 | 17 | 19 | 21 | 23 | 25 | 28 | 31 | 37 |
| Outer diameter (d2) | 24 | 30 | 34 | 37 | 39 | 44 | 50 | 56 | 66 |
| Thickness (S) | 3 | 4 | 4 | 4 | 4 | 4 | 5 | 5 | 6 |

Choice of length according to clamping capacity

Important remarks about clamping capacity

As the thread length of HR bolts is relatively short, a particular attention should be paid to the choice of length according to clamping capacity. If an HR bolt is too long, the body (non-threaded part) of the bolt may exceed the thickness of the steel structure thickness, preventing the required pre-stressing force to be applied. Conversely, in case the bolt is too short, the available thread length is insufficient to effectively resume the pre-stressing force.

Therefore, the following conditions must be fulfilled:

$$(l_{\max} + 2P) < \sum t < (l_{\min} - P - m_{\max})$$

- l_{\max} = maximum body length
- P = screw pitch
- $\sum t$ = clamping capacity
- m_{\max} = maximum nut height
- l_{\min} = nominal screw length

In other words:

$$(body\ length + 2\ pitch) < clamping\ capacity < (nominal\ length - 1\ pitch - 1\ nut\ height)$$

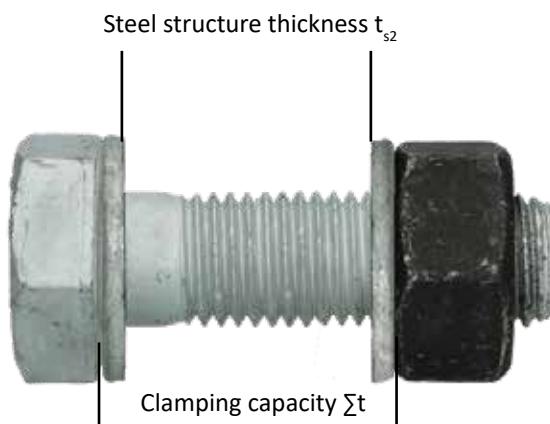
The values indicated in the table on the next page $\sum t_{\min}$ and $\sum t_{\max}$ are within this perimeter. The values for $\sum t_{\max}$ are fixed so that the screw protrudes 1 pitch from the free face of the nut.

Clamping capacity with HR-sets

The definition of the clamping capacity according to EN 14399-3 includes two washers. We must therefore distinguish the tightening capacity of the bolt and the thickness of the steel structure.

Clamping capacity is the distance between the head of the screw and the nut.

Steel structure thickness is the distance between the 2 washers. According to EN 1090-2, to compensate the clamping length, up to three washers of a total thickness not exceeding 12 mm can be installed on the end which is not turned.



Clamping capacity HR-sets

Clamping capacity Σt

| Dim. | M12 | | M14 | | M16 | | M18 | | M20 | | M22 | | M24 | | M27 | | M30 | | M36 | |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| L | min | max |
| 30 | 14 | 16 | | | | | | | | | | | | | | | | | | |
| 40 | 14 | 26 | 16 | 23 | 16 | 21 | | | | | | | | | | | | | | |
| 50 | 27 | 36 | 16 | 33 | 16 | 31 | 20 | 30 | 20 | 28 | 20 | 26 | | | | | | | | |
| 60 | 37 | 45 | 34 | 43 | 30 | 41 | 20 | 40 | 20 | 38 | 20 | 36 | 24 | 34 | 24 | 31 | | | | |
| 70 | 47 | 55 | 44 | 53 | 40 | 51 | 38 | 50 | 34 | 48 | 20 | 46 | 24 | 44 | 24 | 41 | 28 | 39 | | |
| 80 | 57 | 65 | 54 | 63 | 50 | 61 | 48 | 60 | 44 | 58 | 40 | 56 | 24 | 54 | 24 | 51 | 28 | 49 | | |
| 90 | 67 | 75 | 64 | 73 | 60 | 71 | 58 | 69 | 54 | 67 | 50 | 66 | 48 | 63 | 42 | 61 | 28 | 59 | 32 | 53 |
| 100 | 77 | 85 | 74 | 83 | 70 | 81 | 68 | 79 | 64 | 77 | 60 | 76 | 58 | 73 | 52 | 71 | 48 | 69 | 32 | 63 |
| 110 | | | 84 | 93 | 80 | 91 | 78 | 89 | 74 | 87 | 70 | 86 | 68 | 83 | 62 | 81 | 58 | 79 | 32 | 73 |
| 120 | | | 94 | 103 | 90 | 101 | 88 | 99 | 84 | 97 | 80 | 96 | 78 | 93 | 72 | 91 | 68 | 89 | 58 | 83 |
| 130 | | | 98 | 113 | 94 | 111 | 92 | 109 | 88 | 107 | 84 | 106 | 82 | 103 | 76 | 101 | 72 | 98 | 62 | 93 |
| 140 | | | 108 | 123 | 104 | 121 | 102 | 119 | 98 | 117 | 94 | 116 | 92 | 113 | 86 | 111 | 82 | 108 | 72 | 103 |
| 150 | | | 118 | 133 | 114 | 131 | 112 | 129 | 108 | 127 | 104 | 126 | 102 | 123 | 96 | 121 | 92 | 118 | 82 | 113 |
| 160 | | | | | | | | | | | | | | | | | 102 | 126 | 92 | 121 |

Steel construction thickness HR-sets

Steel construction thickness t_{s2}

| Dim. | M12 | | M14 | | M16 | | M18 | | M20 | | M22 | | M24 | | M27 | | M30 | | M36 | |
|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | L | min | max | |
| 30 | 9 | 9 | | | | | | | | | | | | | | | | | | |
| 40 | 9 | 19 | 11 | 17 | 9 | 13 | | | | | | | | | | | | | | |
| 50 | 22 | 29 | 11 | 27 | 9 | 23 | 13 | 21 | 13 | 19 | 13 | 18 | | | | | | | | |
| 60 | 32 | 39 | 29 | 37 | 23 | 33 | 13 | 31 | 13 | 29 | 13 | 28 | 17 | 25 | 16 | 20 | | | | |
| 70 | 42 | 49 | 39 | 47 | 33 | 43 | 31 | 41 | 27 | 39 | 13 | 38 | 17 | 35 | 16 | 30 | 20 | 28 | | |
| 80 | 52 | 59 | 49 | 57 | 43 | 53 | 41 | 51 | 37 | 49 | 33 | 48 | 17 | 45 | 16 | 40 | 20 | 38 | | |
| 90 | 62 | 69 | 59 | 66 | 53 | 62 | 51 | 61 | 47 | 59 | 43 | 57 | 41 | 55 | 34 | 50 | 20 | 47 | 22 | 40 |
| 100 | 72 | 79 | 69 | 76 | 63 | 72 | 61 | 71 | 57 | 69 | 53 | 67 | 51 | 65 | 44 | 60 | 40 | 57 | 22 | 50 |
| 110 | | | 79 | 86 | 73 | 82 | 71 | 81 | 67 | 79 | 63 | 77 | 61 | 75 | 54 | 70 | 50 | 67 | 22 | 60 |
| 120 | | | 89 | 96 | 83 | 92 | 81 | 91 | 77 | 89 | 73 | 87 | 71 | 85 | 64 | 80 | 60 | 77 | 48 | 70 |
| 130 | | | 93 | 106 | 87 | 102 | 85 | 101 | 81 | 98 | 77 | 97 | 75 | 94 | 68 | 90 | 64 | 87 | 52 | 79 |
| 140 | | | 103 | 116 | 97 | 112 | 95 | 111 | 91 | 108 | 87 | 107 | 85 | 104 | 78 | 100 | 74 | 97 | 62 | 89 |
| 150 | | | 113 | 126 | 107 | 122 | 105 | 121 | 101 | 118 | 97 | 117 | 95 | 114 | 88 | 110 | 84 | 107 | 72 | 99 |
| 160 | | | | | | | | | | | | | | | | | 94 | 115 | 82 | 107 |

Tightening torque HR-sets

Tightening torque for class K2 - method in two steps

Step 1 according to EN 1090-2

| Size | $F_{p,c}$ | Initial tightening torque $M_{r,i}$ at 75% in Nm | | | | | | |
|------|-----------|--|------|------|------|------|------|------|
| | | With K= | 0,1 | 0,11 | 0,12 | 0,13 | 0,14 | 0,15 |
| M12 | 59 | 53 | 58 | 64 | 69 | 74 | 80 | 85 |
| M14 | 81 | 85 | 93 | 101 | 110 | 118 | 127 | 135 |
| M16 | 110 | 132 | 145 | 158 | 171 | 185 | 198 | 211 |
| M18 | 134 | 181 | 200 | 218 | 236 | 254 | 272 | 290 |
| M20 | 172 | 257 | 283 | 309 | 334 | 360 | 386 | 412 |
| M22 | 212 | 350 | 385 | 420 | 455 | 490 | 525 | 560 |
| M24 | 247 | 445 | 489 | 534 | 578 | 623 | 667 | 712 |
| M27 | 321 | 651 | 716 | 781 | 846 | 911 | 976 | 1041 |
| M30 | 393 | 884 | 972 | 1060 | 1149 | 1237 | 1325 | 1414 |
| M36 | 572 | 1544 | 1699 | 1853 | 2007 | 2162 | 2316 | 2471 |

Step 2 according to EN 1090-2

| Size | $F_{p,c}$ | Final tightening torque M_r to 110% in Nm | | | | | | |
|------|-----------|---|------|------|------|------|------|------|
| | | With K= | 0,1 | 0,11 | 0,12 | 0,13 | 0,14 | 0,15 |
| M12 | 59 | 78 | 86 | 93 | 101 | 109 | 117 | 125 |
| M14 | 81 | 124 | 136 | 149 | 161 | 174 | 186 | 198 |
| M16 | 110 | 193 | 213 | 232 | 251 | 271 | 290 | 309 |
| M18 | 134 | 266 | 293 | 319 | 346 | 373 | 399 | 426 |
| M20 | 172 | 377 | 415 | 453 | 490 | 528 | 566 | 604 |
| M22 | 212 | 513 | 565 | 616 | 667 | 719 | 770 | 821 |
| M24 | 247 | 652 | 718 | 783 | 848 | 913 | 979 | 1044 |
| M27 | 321 | 954 | 1050 | 1145 | 1241 | 1336 | 1431 | 1527 |
| M30 | 393 | 1296 | 1426 | 1555 | 1685 | 1814 | 1944 | 2073 |
| M36 | 572 | 2265 | 2491 | 2718 | 2944 | 3171 | 3397 | 3624 |

Tip: Tightening torque on the label

The labels of pgb-fasteners show the recommended torque according to EN 14399 for the HR combinations.



Notes

SB-sets

Standards

EN 15048 for SB bolts specifies that all bolted connections must comply with European standards. The standard does not, however, indicate which specific standards apply to the components and merely states general technical requirements. SB bolt sets from pgb contain hexagon nuts ISO 4032. The strength class of the components of the pgb SB bolt sets is 8.8 and they are zinc plated or hot-dip galvanised.

The EN 15048 standard has been developed for non-preloaded structural bolting assemblies. Parts 1 and 2 of this standard describe the requirements and the process to get the "CE" marking. The screws and nuts composing the SB sets can be found in this standard.

An SB set consists of the following elements:

- 1 SB 8.8 hexagon head screw, ISO 4014 or 4017, zinc plated or hot dip galvanized
- 1 hexagonal nut ISO 8, ISO 4032, zinc plated or hot dip galvanized

SB bolting assemblies are relevant in the field of metal construction with only static shear force or simply fasten steel structure components together.

Identification

In order to allow a clear identification of the SB sets, each element bears a marking to identify the product and limit the risk of error. The marking must therefore always remain visible. When mounting the nuts, it is mandatory to ensure that the face bearing the marking is facing outward.



- | | |
|---|---|
| <ul style="list-style-type: none"> • SB designation • Resistance class 8.8 • Manufacturer's symbol 'PGB' • Batch number (eg: B52) | <ul style="list-style-type: none"> • SB designation • Resistance class 8 • Manufacturer's symbol 'PGB' |
|---|---|

Standard range

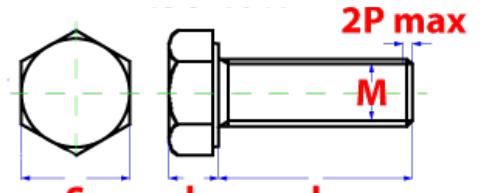
| SB 8.8 bolt | SB nut class 8 |
|----------------|----------------|
| M10 x 20 - 100 | M10 |
| M12 x 25 - 200 | M12 |
| M14 x 30 - 50 | M14 |
| M16 x 30 - 220 | M16 |
| M18 x 40 - 70 | M18 |
| M20 x 40 - 260 | M20 |
| M22 x 50 - 80 | M22 |
| M24 x 50 - 260 | M24 |
| M27 x 60 - 200 | M27 |
| M30 x 70 - 300 | M30 |
| M36 x 90 - 200 | M36 |

Screws and nuts are sold together not assembled.



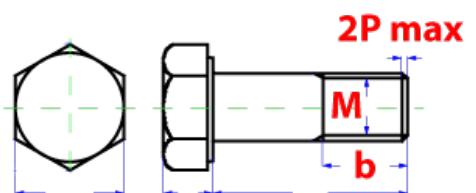
SB combinations

SB hexagonal head screw - 8.8 – ISO 4017



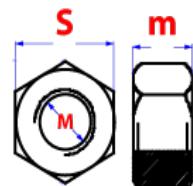
| Size | M10 | M12 | M14 | M16 | M18 | M20 | M22 | M24 | M27 | M30 | M36 |
|--------------------|-----|------|-----|-----|------|------|-----|-----|-----|------|------|
| Socket wrench (S) | 16 | 18 | 21 | 24 | 27 | 30 | 34 | 36 | 41 | 46 | 55 |
| Pitch (P) | 1,5 | 1,75 | 2,0 | 2,0 | 2,5 | 2,5 | 2,5 | 3,0 | 3,0 | 3,5 | 4,0 |
| Head thickness (k) | 6,4 | 7,5 | 8,8 | 10 | 11,5 | 12,5 | 14 | 15 | 17 | 18,7 | 22,5 |

SB hexagonal head screw - 8.8 – ISO 4014



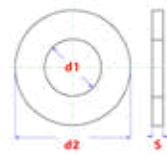
| Size | M10 | M12 | M14 | M16 | M18 | M20 | M22 | M24 | M27 | M30 | M36 |
|-------------------------|-----|------|-----|-----|------|------|-----|-----|-----|------|------|
| Socket wrench (S) | 16 | 18 | 21 | 24 | 27 | 30 | 34 | 36 | 41 | 46 | 55 |
| Pitch (P) | 1,5 | 1,75 | 2,0 | 2,0 | 2,5 | 2,5 | 2,5 | 3,0 | 3,0 | 3,5 | 4,0 |
| Head thickness (k) | 6,4 | 7,5 | 8,8 | 10 | 11,5 | 12,5 | 14 | 15 | 17 | 18,7 | 22,5 |
| Thread length (b) ≤ 125 | 26 | 30 | 34 | 38 | 42 | 46 | 50 | 54 | 60 | 66 | - |
| Thread length (b) ≤ 200 | 32 | 36 | 40 | 44 | 48 | 52 | 56 | 60 | 66 | 72 | 84 |
| Thread length (b) > 200 | 45 | 49 | 53 | 57 | 61 | 65 | 69 | 73 | 79 | 85 | 97 |

SB nut – class 8 – ISO 4032



| Size | M10 | M12 | M14 | M16 | M18 | M20 | M22 | M24 | M27 | M30 | M36 |
|---------------------|-----|------|------|------|------|-----|------|------|------|------|-----|
| Socket wrench (S) | 16 | 18 | 21 | 24 | 27 | 30 | 34 | 36 | 41 | 46 | 55 |
| Nut height (m, max) | 8,4 | 10,8 | 12,8 | 14,8 | 15,8 | 18 | 19,4 | 21,5 | 23,8 | 25,6 | 31 |

Recommended washers - ISO 7089



| Size | M10 | M12 | M14 | M16 | M18 | M20 | M22 | M24 | M27 | M30 | M36 |
|--------------------------|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Thickness (s) | 2,0 | 2,5 | 2,5 | 3,0 | 3,0 | 3,0 | 3,0 | 4,0 | 4,0 | 4,0 | 5,0 |
| Inner diameter (d1, min) | 10,5 | 13 | 15 | 17 | 19 | 21 | 23 | 25 | 28 | 31 | 37 |
| Outer diameter (d2, max) | 20 | 24 | 28 | 30 | 34 | 37 | 39 | 44 | 50 | 56 | 66 |

Choice of length according to clamping capacity

Important remarks about clamping capacity

As the thread length of SB bolts is relatively short, a particular attention should be paid to the choice of length according to clamping capacity. If an SB bolt is too long, the body (non-threaded part) of the bolt may exceed the thickness of the steel structure thickness, preventing the required pre-stressing force to be applied. Conversely, in case the bolt is too short, the available thread length is insufficient to effectively resume the pre-stressing force.

Therefore, the following conditions must be fulfilled:

$$(l_{g_{\max}} + 2P) < \sum t < (l_{\min} - P - m_{\max})$$

- $l_{g_{\max}}$ = maximum body length
- P = screw pitch
- $\sum t$ = clamping capacity
- m_{\max} = maximum nut height
- l_{\min} = nominal screw length

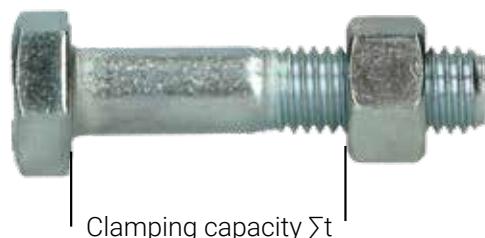
In other words:

$$(body\ length + 2\ pitch) < clamping\ capacity < (nominal\ length - 1\ pitch - 1\ nut\ height)$$

The values indicated in the table on the next page $\sum t_{\min}$ and $\sum t_{\max}$ are within this perimeter. The values for $\sum t_{\max}$ are fixed so that the screw protrudes 1 pitch from the free face of the nut.

Definition of clamping capacity

The definition of the clamping capacity according to EN 15048 doesn't include washers. Clamping capacity is the distance between the head of the screw and the nut. According to EN 1090-2, to compensate the clamping length, up to three washers of a total thickness not exceeding 12 mm can be installed on the end which is not turned.



Clamping capacity SB-bolts

Clamping capacity Σt - ISO 4017

| Size | M10 | | M12 | | M14 | | M16 | | M18 | | M20 | |
|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| L | min | max |
| 20 | 8 | 9 | | | | | | | | | | |
| 25 | 8 | 14 | 9 | 11 | | | | | | | | |
| 30 | 8 | 19 | 9 | 16 | 10 | 14 | 10 | 12 | | | | |
| 35 | 8 | 23 | 9 | 21 | 10 | 19 | 10 | 17 | 13 | 15 | | |
| 40 | 8 | 28 | 9 | 26 | 10 | 24 | 10 | 22 | 13 | 20 | 13 | 18 |
| 45 | 8 | 33 | 9 | 31 | 10 | 29 | 10 | 27 | 13 | 25 | 13 | 23 |
| 50 | 8 | 38 | 9 | 36 | 10 | 34 | 10 | 32 | 13 | 30 | 13 | 28 |
| 55 | 8 | 43 | 9 | 41 | 10 | 38 | 10 | 36 | 13 | 35 | 13 | 33 |
| 60 | 8 | 48 | 9 | 46 | 10 | 43 | 10 | 41 | 13 | 40 | 13 | 38 |
| 65 | 8 | 53 | 9 | 51 | 10 | 48 | 10 | 46 | 13 | 45 | 13 | 43 |
| 70 | 8 | 58 | 9 | 56 | 10 | 53 | 10 | 51 | 13 | 50 | 13 | 48 |
| 75 | 8 | 63 | 9 | 61 | 10 | 58 | 10 | 56 | 13 | 55 | 13 | 53 |
| 80 | 8 | 68 | 9 | 66 | 10 | 63 | 10 | 61 | 13 | 60 | 13 | 58 |
| 85 | 8 | 73 | 9 | 70 | 10 | 68 | 10 | 66 | 13 | 65 | 13 | 62 |
| 90 | 8 | 78 | 9 | 75 | 10 | 73 | 10 | 71 | 13 | 70 | 13 | 67 |
| 95 | 8 | 83 | 9 | 80 | 10 | 78 | 10 | 76 | 13 | 75 | 13 | 72 |
| 100 | 8 | 88 | 9 | 85 | 10 | 83 | 10 | 81 | 13 | 80 | 13 | 77 |
| 105 | | | 9 | 90 | 10 | 88 | 10 | 86 | 13 | 85 | 13 | 82 |
| 110 | | | 9 | 95 | 10 | 93 | 10 | 91 | 13 | 90 | 13 | 87 |
| 115 | | | 9 | 100 | 10 | 98 | 10 | 96 | 13 | 95 | 13 | 92 |
| 120 | | | 9 | 105 | 10 | 103 | 10 | 101 | 13 | 100 | 13 | 97 |
| 125 | | | | | 10 | 108 | 10 | 106 | 13 | 104 | 13 | 102 |
| 130 | | | | | 10 | 113 | 10 | 111 | 13 | 109 | 13 | 107 |
| 135 | | | | | 10 | 118 | 10 | 116 | 13 | 114 | 13 | 112 |
| 140 | | | | | 10 | 123 | 10 | 121 | 13 | 119 | 13 | 117 |
| 145 | | | | | | | 10 | 126 | 13 | 124 | 13 | 122 |
| 150 | | | | | | | 10 | 131 | 13 | 129 | 13 | 127 |
| 155 | | | | | | | | | | | | |
| 160 | | | | | | | | | | | | |
| 165 | | | | | | | | | | | | |
| 170 | | | | | | | | | | | | |
| 175 | | | | | | | | | | | | |
| 180 | | | | | | | | | | | | |
| 185 | | | | | | | | | | | | |
| 190 | | | | | | | | | | | | |
| 195 | | | | | | | | | | | | |
| 200 | | | | | | | | | | | | |

Clamping capacity Σt - ISO 4017

| Size | M22 | | M24 | | M27 | | M30 | | M36 | | |
|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | L | min | max |
| 20 | | | | | | | | | | | |
| 25 | | | | | | | | | | | |
| 30 | | | | | | | | | | | |
| 35 | | | | | | | | | | | |
| 40 | 13 | 18 | | | | | | | | | |
| 45 | 13 | 23 | | | | | | | | | |
| 50 | 13 | 28 | 15 | 24 | | | | | | | |
| 55 | 13 | 33 | 15 | 29 | 15 | 26 | | | | | |
| 60 | 13 | 38 | 15 | 34 | 15 | 31 | 18 | 29 | | | |
| 65 | 13 | 43 | 15 | 39 | 15 | 36 | 18 | 34 | | | |
| 70 | 13 | 48 | 15 | 44 | 15 | 41 | 18 | 39 | 20 | 33 | |
| 75 | 13 | 53 | 15 | 49 | 15 | 46 | 18 | 44 | 20 | 38 | |
| 80 | 13 | 58 | 15 | 54 | 15 | 51 | 18 | 49 | 20 | 43 | |
| 85 | 13 | 62 | 15 | 58 | 15 | 56 | 18 | 54 | 20 | 48 | |
| 90 | 13 | 67 | 15 | 63 | 15 | 61 | 18 | 59 | 20 | 53 | |
| 95 | 13 | 72 | 15 | 68 | 15 | 66 | 18 | 64 | 20 | 58 | |
| 100 | 13 | 77 | 15 | 73 | 15 | 71 | 18 | 69 | 20 | 63 | |
| 105 | 13 | 82 | 15 | 78 | 15 | 76 | 18 | 74 | 20 | 68 | |
| 110 | 13 | 87 | 15 | 83 | 15 | 81 | 18 | 79 | 20 | 73 | |
| 115 | 13 | 92 | 15 | 88 | 15 | 86 | 18 | 84 | 20 | 78 | |
| 120 | 13 | 97 | 15 | 93 | 15 | 91 | 18 | 89 | 20 | 83 | |
| 125 | 13 | 102 | 15 | 98 | 15 | 96 | 18 | 93 | 20 | 88 | |
| 130 | 13 | 107 | 15 | 103 | 15 | 101 | 18 | 98 | 20 | 93 | |
| 135 | 13 | 112 | 15 | 108 | 15 | 106 | 18 | 103 | 20 | 98 | |
| 140 | 13 | 117 | 15 | 113 | 15 | 111 | 18 | 108 | 20 | 103 | |
| 145 | 13 | 122 | 15 | 118 | 15 | 116 | 18 | 113 | 20 | 108 | |
| 150 | 13 | 127 | 15 | 123 | 15 | 121 | 18 | 118 | 20 | 113 | |
| 155 | | | | | 15 | 126 | 18 | 123 | 20 | 118 | |
| 160 | | | | | 15 | 131 | 18 | 128 | 20 | 123 | |
| 165 | | | | | 15 | 136 | 18 | 133 | 20 | 128 | |
| 170 | | | | | 15 | 141 | 18 | 138 | 20 | 133 | |
| 175 | | | | | 15 | 146 | 18 | 143 | 20 | 138 | |
| 180 | | | | | 15 | 151 | 18 | 148 | 20 | 143 | |
| 185 | | | | | 15 | 155 | 18 | 153 | 20 | 147 | |
| 190 | | | | | 15 | 160 | 18 | 158 | 20 | 152 | |
| 195 | | | | | 15 | 165 | 18 | 163 | 20 | 157 | |
| 200 | | | | | 15 | 170 | 18 | 168 | 20 | 162 | |

Clamping capacity Σt - ISO 4014

| Size | M10 | | M12 | | M14 | | M16 | | M18 | | M20 | | |
|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | L | min | max |
| 45 | | 22 | 33 | 19 | 31 | | | | | | | | |
| 50 | | 27 | 38 | 24 | 36 | | | | | | | | |
| 55 | | 32 | 43 | 29 | 41 | | | 21 | 36 | | | | |
| 60 | | 37 | 48 | 34 | 46 | 30 | 43 | 26 | 41 | 23 | 40 | | |
| 65 | | 42 | 53 | 29 | 51 | 35 | 48 | 31 | 46 | 28 | 45 | 24 | 43 |
| 70 | | 47 | 58 | 44 | 56 | 40 | 53 | 36 | 51 | 33 | 50 | 29 | 48 |
| 75 | | 52 | 63 | 49 | 61 | 45 | 58 | 41 | 56 | 38 | 55 | 34 | 53 |
| 80 | | 57 | 68 | 54 | 66 | 50 | 63 | 46 | 61 | 43 | 60 | 39 | 58 |
| 85 | | 62 | 73 | 59 | 70 | 55 | 68 | 51 | 66 | 48 | 65 | 44 | 62 |
| 90 | | 67 | 78 | 64 | 75 | 60 | 73 | 56 | 71 | 53 | 70 | 49 | 67 |
| 95 | | 72 | 83 | 69 | 80 | 65 | 78 | 61 | 76 | 58 | 75 | 54 | 72 |
| 100 | | 77 | 88 | 74 | 85 | 70 | 83 | 66 | 81 | 63 | 80 | 59 | 77 |
| 105 | | | | 79 | 90 | 75 | 88 | 71 | 86 | 68 | 85 | 64 | 82 |
| 110 | | | | 84 | 95 | 80 | 93 | 76 | 91 | 73 | 90 | 69 | 87 |
| 115 | | | | 89 | 100 | 85 | 98 | 81 | 96 | 78 | 95 | 74 | 92 |
| 120 | | | | 94 | 105 | 90 | 103 | 86 | 101 | 83 | 100 | 79 | 97 |
| 125 | | | | 99 | 110 | 95 | 108 | 91 | 106 | 88 | 104 | 84 | 102 |
| 130 | | | | 98 | 115 | 94 | 113 | 90 | 111 | 87 | 109 | 83 | 107 |
| 135 | | | | 103 | 120 | 99 | 118 | 95 | 116 | 92 | 114 | 88 | 112 |
| 140 | | | | 108 | 125 | 104 | 123 | 100 | 121 | 97 | 119 | 93 | 117 |
| 145 | | | | 113 | 130 | | | 105 | 126 | 102 | 124 | 98 | 122 |
| 150 | | | | 118 | 135 | | | 110 | 131 | 107 | 129 | 103 | 127 |
| 155 | | | | 123 | 140 | | | 115 | 136 | 112 | 134 | 108 | 132 |
| 160 | | | | 128 | 145 | | | 120 | 141 | 117 | 139 | 113 | 137 |
| 165 | | | | 133 | 150 | | | 125 | 146 | 122 | 144 | 118 | 142 |
| 170 | | | | 138 | 155 | | | 130 | 151 | 127 | 149 | 123 | 147 |
| 175 | | | | 143 | 160 | | | 135 | 156 | 132 | 154 | 128 | 152 |
| 180 | | | | 148 | 165 | | | 140 | 161 | 137 | 159 | 133 | 157 |
| 185 | | | | 153 | 170 | | | 145 | 165 | | | 138 | 162 |
| 190 | | | | 158 | 175 | | | 150 | 170 | | | 143 | 167 |
| 195 | | | | 163 | 180 | | | 155 | 175 | | | 148 | 172 |
| 200 | | | | 168 | 185 | | | 160 | 180 | | | 153 | 177 |
| 210 | | | | | | | | 157 | 190 | | | 150 | 187 |
| 220 | | | | | | | | 167 | 200 | | | 160 | 197 |
| 230 | | | | | | | | 177 | 210 | | | 170 | 207 |
| 240 | | | | | | | | 187 | 220 | | | 180 | 217 |
| 250 | | | | | | | | 197 | 230 | | | 190 | 227 |
| 260 | | | | | | | | 207 | 240 | | | 200 | 236 |
| 270 | | | | | | | | | | | | | |
| 280 | | | | | | | | | | | | | |
| 290 | | | | | | | | | | | | | |
| 300 | | | | | | | | | | | | | |

Clamping capacity Σt - ISO 4014

| Size | M22 | | M24 | | M27 | | M30 | | M36 | | |
|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | L | min | max |
| 45 | | | | | | | | | | | |
| 50 | | | | | | | | | | | |
| 55 | | | | | | | | | | | |
| 60 | | | | | | | | | | | |
| 65 | | | | | | | | | | | |
| 70 | | | 22 | 44 | | | | | | | |
| 75 | | | 27 | 49 | | | | | | | |
| 80 | | | 32 | 54 | 26 | 51 | | | | | |
| 85 | | | 37 | 58 | 31 | 56 | | | | | |
| 90 | 45 | 67 | 42 | 63 | 36 | 61 | 31 | 59 | | | |
| 95 | 50 | 72 | 47 | 68 | 41 | 66 | 36 | 64 | | | |
| 100 | 55 | 77 | 52 | 73 | 46 | 71 | 41 | 69 | 24 | 63 | |
| 105 | 60 | 82 | 57 | 78 | 51 | 76 | 46 | 74 | 29 | 68 | |
| 110 | 65 | 87 | 62 | 83 | 56 | 81 | 51 | 79 | 34 | 73 | |
| 115 | 70 | 92 | 67 | 88 | 61 | 86 | 56 | 84 | 39 | 78 | |
| 120 | 75 | 97 | 72 | 93 | 66 | 91 | 61 | 89 | 44 | 83 | |
| 125 | 80 | 102 | 77 | 98 | 71 | 96 | 66 | 93 | 49 | 88 | |
| 130 | 79 | 107 | 76 | 103 | 70 | 101 | 65 | 98 | 54 | 93 | |
| 135 | 84 | 112 | 81 | 108 | 75 | 106 | 70 | 103 | 59 | 98 | |
| 140 | 89 | 117 | 86 | 113 | 80 | 111 | 75 | 108 | 64 | 103 | |
| 145 | 94 | 122 | 91 | 118 | 85 | 116 | 80 | 113 | 69 | 108 | |
| 150 | 99 | 127 | 96 | 123 | 90 | 121 | 85 | 118 | 74 | 113 | |
| 155 | 104 | 132 | 101 | 128 | 95 | 126 | 90 | 123 | 79 | 118 | |
| 160 | 109 | 137 | 106 | 133 | 100 | 131 | 95 | 128 | 84 | 123 | |
| 165 | 114 | 142 | 111 | 138 | 105 | 136 | 100 | 133 | 89 | 128 | |
| 170 | 119 | 147 | 116 | 143 | 110 | 141 | 105 | 138 | 94 | 133 | |
| 175 | 124 | 152 | 121 | 148 | 115 | 146 | 110 | 143 | 99 | 138 | |
| 180 | 129 | 157 | 126 | 153 | 120 | 151 | 115 | 148 | 104 | 143 | |
| 185 | 134 | 162 | 131 | 158 | 125 | 155 | 120 | 153 | 109 | 147 | |
| 190 | 139 | 167 | 136 | 163 | 130 | 160 | 125 | 158 | 114 | 152 | |
| 195 | 144 | 172 | 141 | 168 | 135 | 165 | 130 | 163 | 119 | 157 | |
| 200 | 149 | 177 | 146 | 173 | 140 | 170 | 135 | 168 | 124 | 162 | |
| 210 | 146 | 187 | 143 | 183 | 137 | 180 | 132 | 178 | 121 | 172 | |
| 220 | 156 | 197 | 153 | 193 | 147 | 190 | 142 | 188 | 131 | 182 | |
| 230 | | | 163 | 203 | 157 | 200 | 152 | 198 | 141 | 192 | |
| 240 | | | 173 | 213 | 167 | 210 | 162 | 208 | 151 | 202 | |
| 250 | | | 183 | 223 | 177 | 220 | 172 | 218 | 161 | 212 | |
| 260 | | | 193 | 232 | 187 | 230 | 182 | 228 | 171 | 222 | |
| 270 | | | | | | | 192 | 238 | 181 | 232 | |
| 280 | | | | | | | 202 | 248 | 191 | 242 | |
| 290 | | | | | | | 212 | 258 | 201 | 252 | |
| 300 | | | | | | | 222 | 268 | 211 | 262 | |



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