〔TECHNICAL DATA〕

TABLE OF DIAMETER OF SCREW LOW HOLE（LOW ANCHOR）

1. Meter coarse thread

Nominal size of thread	Minimum dimensions Grade 2, Grade 3	Maximum dimensions Grade 2	Maximum dimensions Grade 3
M 1×0.25	0.73	0.78	—
M 1.1×0.25	0.83	0.89	—
M 1.2×0.25	0.93	0.98	—
M 1.4×0.3	1.08	1.14	—
M 1.6×0.35	1.22	1.32	—
M 1.7×0.35	1.33	1.42	—
M 1.8×0.35	1.42	1.52	—
M 2×0.4	1.57	1.67	—
M 2.2×0.45	1.71	1.84	—
M 2.3×0.4	1.87	1.97	—
M 2.5×0.45	2.01	2.14	—
M 2.6×0.45	2.12	2.23	—
M 3×0.5	2.46	2.60	2.64
M 3.5×0.6	2.85	3.01	3.05
M 4×0.7	3.24	3.42	3.47
M 4.5×0.75	3.69	3.88	3.92
M 5×0.8	4.13	4.33	4.38
M 6×1	4.92	5.15	5.22
M 7×1	5.92	6.15	6.22
M 8×1.25	6.65	6.91	6.98
M 9×1.25	7.65	7.91	7.98
M 10×1.5	8.38	8.68	8.75
M 11×1.5	9.38	9.68	9.75
M 12×1.75	10.11	10.44	10.53
M 14×2	11.84	12.21	12.31
M 16×2	13.84	14.21	14.31
M 18×2.5	15.29	15.74	15.85
M 20×2.5	17.29	17.74	17.85
M 22×2.5	19.29	19.74	19.85
M 24×3	20.75	21.25	21.38
M 27×3	23.75	24.25	24.38
M 30×3.5	26.21	26.77	26.92
M 33×3.5	29.21	29.77	29.92
M 36×4	31.67	32.27	32.42
M 39×4	34.67	35.27	35.42
M 42×4.5	37.13	37.80	37.98
M 45×4.5	40.13	40.80	40.98
M 48×5	42.59	43.30	43.49

Nominal size of thread	Minimum dimensions Grade 2, Grade 3	Maximum dimensions Grade 2	Maximum dimensions Grade 3
M 16×1.5	14.38	14.68	14.75
M 16×1	14.92	15.15	15.22
M 17×1.5	15.38	15.68	15.75
M 17×1	15.92	16.15	16.22
M 18×2	15.84	16.21	16.31
M 18×1.5	16.38	16.68	16.75
M 18×1	16.92	17.15	17.22
M 20×2	17.84	18.21	18.31
M 20×1.5	18.38	18.68	18.75
M 20×1	18.92	19.15	19.22
M 22×2	19.84	20.21	20.31
M 22×1.5	20.38	20.68	20.75
M 22×1	20.92	21.15	21.22
M 24×2	21.84	22.21	22.31
M 24×1.5	22.38	22.68	22.75
M 24×1	22.92	23.15	23.22
M 25×2	22.84	23.21	23.31
M 25×1.5	23.38	23.68	23.75
M 25×1	23.92	24.15	24.22
M 26×1.5	24.38	24.68	24.75
M 27×2	24.84	25.21	25.31
M 27×1.5	25.38	25.68	25.75
M 27×1	25.92	26.15	26.22
M 28×2	25.84	26.21	26.31
M 28×1.5	26.38	26.68	26.75
M 28×1	26.92	27.15	27.22
M 30×3	26.75	27.25	27.38
M 30×2	27.84	28.21	28.31
M 30×1.5	28.38	28.68	28.75
M 30×1	28.92	29.15	29.22
M 32×2	29.84	30.21	30.31
M 32×1.5	30.38	30.68	30.75
M 33×3	29.75	30.25	30.38
M 33×2	30.84	31.21	31.31
M 33×1.5	31.38	31.68	31.75
M 35×1.5	33.38	33.68	33.75
M 36×3	32.75	33.25	33.38
M 36×2	33.84	34.21	34.31
M 36×1.5	34.38	34.68	34.75
M 38×1.5	36.38	36.68	36.75
M 39×3	35.75	36.25	36.38
M 39×2	36.84	37.21	37.31
M 39×1.5	37.38	37.68	37.75
M 40×3	36.75	37.25	37.38
M 40×2	37.84	38.21	38.31
M 40×1.5	38.38	38.68	38.75
M 42×4	37.67	38.27	38.42
M 42×3	38.75	39.25	39.38
M 42×2	39.84	40.21	40.31
M 42×1.5	40.38	40.68	40.75
M 45×4	40.67	41.27	41.42
M 45×3	41.75	42.25	42.38
M 45×2	42.84	43.21	43.31
M 45×1.5	43.38	43.68	43.75
M 48×4	43.67	44.27	44.42
M 48×3	44.75	45.25	45.38
M 48×2	45.84	46.21	46.31
M 48×1.5	46.38	46.68	46.75
M 50×3	46.75	47.25	47.38
M 50×2	47.84	48.21	48.31
M 50×1.5	48.38	48.68	48.75

2. Meter fine thread

Nominal size of thread	Minimum dimensions Grade 2, Grade 3	Maximum dimensions Grade 2	Maximum dimensions Grade 3
M 2.5×0.35	2.12	2.22	—
M 3×0.35	2.62	2.72	—
M 3.5×0.35	3.12	3.22	—
M 4×0.5	3.46	3.60	3.64
M 4.5×0.5	3.96	4.10	4.14
M 5×0.5	4.46	4.60	4.64
M 5.5×0.5	4.96	5.10	5.14
M 6×0.75	5.19	5.38	5.42
M 7×0.75	6.19	6.38	6.42
M 8×1	6.92	7.15	7.22
M 8×0.75	7.19	7.38	7.42
M 9×1	7.92	8.15	8.22
M 9×0.75	8.19	8.38	8.42
M 10×1.25	8.65	8.91	8.98
M 10×1	8.92	9.15	9.22
M 10×0.75	9.19	9.38	—
M 11×1	9.92	10.15	10.22
M 11×0.75	10.19	10.38	10.42
M 12×1.5	10.38	10.68	10.75
M 12×1.25	10.65	10.91	10.98
M 12×1	10.92	11.15	11.22
M 14×1.5	12.38	12.68	12.75
M 14×1	12.92	13.15	13.22
M 15×1.5	13.38	13.68	13.75
M 15×1	13.92	14.15	14.22

〔TECHNICAL DATA〕

CORRECT TIGHTENING AXIAL FORCE AND CORRECT TIGHTENING TORQUE FOR BOLTS

■The tightening tension and fatigue limit when clamping with bolts

- The calculation of the correct tightening torque is to be within the elastic behavior limit, and a maximum of 70% of the standard yield strength under the Torque Method.
- The fatigue limit from repeated loads on the bolt should not exceed the allowable value.
- The flange of a bolt or nut should not be sunk into the clamped surface.
- The surface to be clamped should not be damaged through the tightening of bolts.

The Torque Method, the Torque Gradient Method, the Turn-of-Nut Method, and the Stretch Measurement Method can all be used as the method of bolt tightening, but the Torque Method is relatively simple and is widely used.

■Calculation of the tightening axial force and tightening torque

The relationship of the tightening axial force Ff is expressed in formula (1).

$Ff = 0.7 \times \sigma y \times As \cdots\cdots (1)$

The tightening torque T_{fA}, is expressed in formula (2).

$T_{fA} = 0.35k(1+1/Q)\,\sigma y \cdot As \cdot d \cdots\cdots (2)$

k ： torque coefficient
d ：nominal bolt diameter [cm]
Q ：tightening coefficient
σy ：yield strength (112 kgf/mm^2 when strength category is 12.9)
As ： effective bolt area [mm^2]

■Calculation Example

The correct torque and axial force is required to clamp two pieces of soft steel (strength category of 12.9) with a socket head cap screw M6 in a lubricated state.

- The correct torque is shown using formula (2)

$T_{fA} = 0.35k(1+1/Q)\,\sigma y \cdot As \cdot d$
$= 0.35 \cdot 0.17(1+1/1.4)\,112 \cdot 20.1 \cdot 0.6$
$= 138$ [kgf・cm]

- The correct axial tension is shown using formula (1)

$Ff = 0.7 \times \sigma y \times As$
$= 0.7 \times 112 \times 20.1$
$= 1576$ [kgf]

■Torque coefficient by combining the surface treatment of the bolt, the surface to be clamped, and the female screw.

Bolt Surface treatment Lubricant	Torque coefficient k	Combining Material of surface to be clamped—Material of female screw (a) (b)
Steel bolts Black oxide coating Lubricated	0.145	SCM—FC FC—FC SUS—FC
	0.155	S10C—FC SCM—S10C SCM—SCM FCS10C FC—SCM
	0.165	SCM—SUS FC—SUS AL—FC SUS—S10C SUS—SCM SUS—SUS
	0.175	S10C—S10C S10C—SCM S10C—SUS AL—S10C AL—SCM
	0.185	SCM—AL FC—AL AL—SUS
	0.195	S10C—AL SUS—AL
	0.215	AL—AL
Steel bolts Black oxide coating Not lubricated	0.25	S10C—FC SCM—FC FC—FC
	0.35	S10C—SCM SCM—SCM FC—S10C FC—SCM AL—FC
	0.45	S10C—S10C SCM—S10C AL—S10C AL—SCM
	0.55	SCM—AL FC—AL AL—AL

S10C: Non heat-treated steel SCM:Heat-treated steel (35HRC) FC:Cast iron (FC200) AL:Aluminum SUS:Stainless (SUS304)

■The standard values of tightening coefficient Q

Tightening coefficient Q	Tightening method	Surface state Bolt	Surface state Nut	Lubrication state
1.25	Torque wrench	Manganese phosphate	Non-treated or phosphate	Lubricated or MoS_2 paste
1.4	Torque wrench	Non-treated or phosphate		
	Ratchet wrench			
1.6	Impact wrench			
1.8	Torque wrench	Non-treated or phosphate	Non-treated	Not lubricated
	Ratchet wrench			

Expressing strength categories

Example 12.9
- Yield strength：90% of the minimum tensile strength
- The minimal tensile strength is 1220N/mm^2 {124kgf/mm^2}

10.9
- Yield strength：90% of the minimum tensile strength
- The minimal tensile strength is 1040N/mm^2 {106kgf/mm^2}

■Initial tightening strength and torque

Bolt size	Effective bolt area As mm^2	Strength category 12.9 Yield load kgf	12.9 Initial tightening strength kgf	12.9 Tightening torque kgf・cm	10.9 Yield load kgf	10.9 Initial tightening strength kgf	10.9 Tightening torque kgf・cm	8.8 Yield load kgf	8.8 Initial tightening strength kgf	8.8 Tightening torque kgf・cm	4.8 Yield load kgf	4.8 Initial tightening strength kgf	4.8 Tightening torque kgf・cm
M 3×0.5	5.03	563	394	17	482	338	15	328	230	10	175	122	5
M 4×0.7	8.78	983	688	40	842	589	34	573	401	23	305	213	12
M 5×0.8	14.2	1590	1113	81	1362	953	69	927	649	47	493	345	25
M 6×1	20.1	2251	1576	138	1928	1349	118	1313	919	80	697	488	43
M 8×1.25	36.6	4099	2869	334	3510	2457	286	2390	1673	195	1270	889	104
M10×1.5	58	6496	4547	663	5562	3894	567	3787	2651	386	2013	1409	205
M12×1.75	84.3	9442	6609	1160	8084	5659	990	5505	3853	674	2925	2048	358
M14×2	115	12880	9016	1840	11029	7720	1580	7510	5257	1070	3991	2793	570
M16×2	157	17584	12039	2870	15056	10539	2460	10252	7176	1670	5448	3814	889
M18×2.5	192	21504	15053	3950	18413	12889	3380	12922	9045	2370	6662	4664	1220
M20×2.5	245	27440	19208	5600	23496	16447	4790	16489	11542	3360	8502	5951	1730
M22×2.5	303	33936	23755	7620	29058	20340	6520	20392	14274	4580	10514	7360	2360
M24×3	353	39536	27675	9680	33853	23697	8290	23757	16630	5820	12249	8574	3000

(Notes)
- Tightening conditions：The use of a torque wrench (lubrication, torque coefficient k=0.17, tightening coefficient Q=1.4)
- The torque coefficient changes depending on conditions of use, so please use this table as an indication only.
- This table is an edited except from a catalogue from KYOKUTO MFG.CO., Ltd