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Version: 2

Kalmar Group Standard **KGS 50701**

Part
Method Standard

Group
Manufacturing Methods

Name
Tightening Torques for Screw Joints

1 Scope
This Kalmar Group Standard, hereinafter referred to as KGS, covers tightening torques in screw joints made of steel material, both for development and for producing Kalmar Mobile Solutions (KAMOS) products.

2 Purpose
The purpose of this KGS is to ensure right tightening torque is provided in a screw joint. The pretension is necessary for a screw joint to withstand large static or alternating forces for a long time. The preload force must be made so that the total tension in the screw composed of tensile stress and torsional stress does not exceed the yield strength of the screw material.

3 Responsibilities
- Design engineer – For the purpose of properly specifying torque. The design engineer should make reference to this standard on drawings where bolted joints are used
- Production Engineer - Ensures that work instructions are correct and up to date with regard to tightening torques for production personnel
- Lead Standardization Engineer - Should stay updated in close consultation with the Principal System Engineer (PSE) for any changes that require updating of this document

4 Definitions
Abbreviation description:

M_V	Tightening torque [Nm]
F_{Fm}	Average preload force [kN]
flZn	Zinc-flake coating
M	Thread
P	Pitch [mm]
A_S	Stress area [mm2]
$σ_S$	Yield point [N/mm2]
G_F	Pre-stress grade
C	Conversion factor

5 Records / References / Attachments

KGS 80101	Designation - Screw
KGS 80103	Designation - Circular washer
ISO 6789-1	Assembly tools for screws and nuts - Hand torque tools - Part 1
ISO 6789-2	Assembly tools for screws and nuts - Hand torque tools - Part 2
ISO 898-5	Mechanical properties of fasteners made of carbon steel and alloy steel - Part 5

6 Procedure Description

The torque tables are to be seen as guideline values. In the case of critical joints, a calculation should be made that takes into account more factors and variations in the specific load case than what these tables show. Tables 1 and 2 show the torques required to reach the average preload force at which the screw reaches its yield strength

The accuracy of different tightening methods (torque wrench, screwdriver or nutrunner with adjustable tightening torques, complies with requirements according to ISO 6789, see section 5) entails that the spread in the torques varies within different large intervals.
If there is uncertainty in the tightening torque within the screw joint, then one should consider lowering the tightening torque so the screw joint does not exceed its yield strength.

The tables 1 and 2 give the values of tightening torque Mv in the different property classes, for screws and nuts in flZn treated steel. Plain flZn washer (A), and Wedge lock washers (B)

Table 3 Tightening torque for other combinations than flZn
Table 4 Average preload force for calculations
Table 5 Tightening torque for set screws

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Additional Requirements

Countersunk screws

Because the force does not fall perpendicular to the thread axis the tightening torque from table 1 or 2 shall be used with an increase by 30%.

Flange screw and flange nuts

The flange causes the contact surface to increase and thus friction. When using screws and nuts with a flange, therefore the tightening torque from table 1 or 2 shall be used with an increase by 10%.

Set screws

Because the set screws lack a head, the friction becomes significantly lower.Therefore, when using set screws, see Table 5.

Painted surfaces

Painted or coated surfaces usually decrease the friction between the screw or the nut. This means that the risk of the preload force becomes too high in the screw joint. The risk of settling in the screw joint increases with paint which leads to loss of the preload force.
In the case of critical screw joints, it is therefore recommended to mask these surfaces before painting.

Indication on drawing

The tightening torque and if using any form of lubricant in the screw joint, must always be specified on the drawing in accordance with Figure 1.

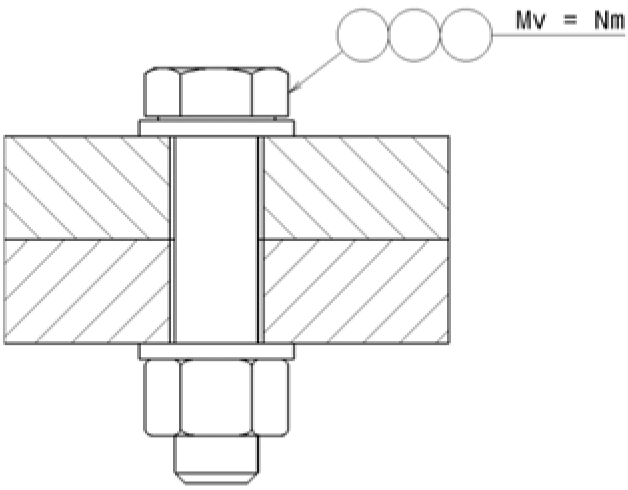

Figure 1.

Examples
Screw: ISO 4014 M12x60-8.8-flZn-Silver
Washer: ISO 7089 13-24-2.5-200HV-flZn-Silver

Example 1:
Conversion of tightening torque for flZn screw at a tapped thread.
Conversion factor C = 1.0 for flZn, according to table 3
Tightening torque Mv(A) 80 [Nm], according to table 1.

Example 2:
Conversion of tightening torque for screw with corresponding dimension and strength class fixed with fastening in threaded hole instead of flZn nut.
Conversion factor C = 0.94, according to table 3
Tightening torque Mv(A) for M12 screw flZn treated in threaded hole.
80 x 0.94 = 75 [Nm]

Table 1: Metric pitch thread Values in table 1 are given in dry condition.

Note: See heading Additional Requirements when using: Flange screws and nuts
Set screws
Countersunk screw

(A) Plain washer (flZn), (B) Wedge lock washer

M (mm)	P (mm)	As (mm2)	Property class								
			8.8			10.9			12.9		
			Mv (A)	Mv (B)	FFm (A)	Mv (A)	Mv (B)	FFm (A)	Mv (A)	Mv (B)	FFm (A)
4	0.7	8.75	2.9	3.5	3.9	4.0	4.5	5.5	4.9	5	6.6
5	0.8	14.2	5.7	7.2	6.4	8.1	9.1	9	9.7	10	10.8
6	1	20.1	9.7	12	9	14	15.3	13.2	16.3	17	15.8
8	1.25	36.6	24	29	17.2	33	37	24.2	40	42	29
10	1,5	58	46	57	26	65	73	37	78	81	44
12	1.75	84.2	80	98	38	112	125	54	134	140	65
16	2	157	196	243	73	276	310	102	331	347	123
20	2.5	245	383	475	114	539	606	160	646	677	192
24	3	353	658	815	163	925	1040	230	1110	1164	275
30	3.5	561	1315	1635	260	1850	2080	368	2220	2330	440
36	4	817	2290	2850	380	3220	3640	535	3860	4050	645

Table 2: Metric pitch thread Values in table 2 are given in dry condition.

Note: See heading Additional Requirements when using: Flange screws and nuts
Set screws
Countersunk screw

(A) Plain washer (flZn), (B) Wedge lock washer

M (mm)	P (mm)	As (mm2)	Property class 8.8 Mv (A)	8.8 Mv (B)	8.8 FFm (A)	10.9 Mv (A)	10.9 Mv (B)	10.9 FFm (A)	12.9 Mv (A)	12.9 Mv (B)	12.9 FFm (A)
4x0.5	0.5	9.79	3.1	4	-	4.3	5	-	5.2	5.6	-
5x0.5	0.5	16.1	6.2	7.7	-	8.7	10.3	-	10	11.3	-
6x0.75	0.75	22	10	13	-	15	17	-	17	19	-
8x1	1	39.2	25	30	18.2	35	40	26	43	44	31
10x1.25	1.25	61.2	49	61	28	68	77.6	40	82	86	48
12x1.25	1.5	92.1	87	110	43	122	138	61	146	153	73
16x1.5	1.5	167	208	260	79	293	330	111	352	369	133
18x1.5	1.5	216	305	380	103	428	483	145	510	538	174
20x1.5	1.5	272	424	530	131	597	675	184	716	752	220
24x2	2	384	717	865	183	1008	1140	258	1210	1270	310
30x2	2	621	1450	1815	300	2040	2310	420	2450	2570	505
36x3	3	865	2420	3020	410	3405	3845	580	4090	4290	695

Table 3: Conversion factor C and prestress grade GF

Screw	Nut or Threaded hole	C	GF
Steel flZn	Steel flZn	1.00	0.70
	Steel untreated	0.94	0.78
Steel untreated	Steel untreated	1.05	0.70

Table 4: Average preload force

Average preload force is calculated
FFm = Ϭs x As x GF

Property class	8.8	10.9	12.9
Ϭs	640	900	1080

Table 5: Proof torque requirements using set screws

According to ISO 898-5, Table 5.
The set screw shall withstand proof torque without splitting or cracking. See the specified torques for different types of set screws in the table below.

M **(mm)** coarse or fine pitch	Minimum length **(mm)** hexagonal socket set screws[a]				**Proof torque** **Nm**
	Flat Point	**Cone Point**	**Dog Point**	**Cup Point**	
3	4	5	6	5	**0,9**
4	5	6	8	6	**2,5**
5	6	8	8	6	**5**
6	8	8	10	8	**8,5**
8	10	10	12	10	**20**
10	12	12	16	12	**40**
12	16	16	20	16	**65**
16	20	20	25	20	**160**
20	25	25	30	25	**310**
24	30	30	35	30	**520**
30	36	36	45	36	**860**
[a] For hexalobular socket set screws, there is no requirement for minimum length (as t_{min} of the socket is the same for all lengths).					