COMPANY NAME	Calculation No. CALCULATION NUMBER
CALCULATION SHEET onlinestructuraldesign.com	Project No. PROJECT NUMBER

Project Title:	**Project Name**	**Calc. By**	**Date**	**Rev.**
		Author	**today**	**0**
Subject/Feature:	**Bolt Preloading Force - Classes 8.8 and 10.9 (Eurocode 3)**	**Checked By**	**Date**	
		Checker	**today**	

Bolt preloading force - Classes 8.8 and 10.9 (Eurocode 3) per EN 1993-1-8 and EN 1090-2

Input	Output
Bolt type, class and diameter	Bolt design preload (tension in bolt)
Partial factors for steel bolts	Bolt torque reference value for tightening (slip ressistant connection)
	Bolt torque value for tightening (non-slip ressistant connection)

Bolts Type 16 bolt diameter - d

A_s = 157 mm^2 bolt effective area in threaded region

Bolt class 10.9

per EN 1993-1-8
Section 3 Table 3.1
bolt classes recommended by the Eurocode;
The National Annex may exclude certain bolt classes.

Bold yield strength f_{yb} = 900 N/mm^2

Bolt ultimate tensile strength f_{ub} = 1000 N/mm^2

Partial factor for steel bolts

γ_{M2} = 1.25

γ_{M7} = 1.1

per EN 1993-1-8
Section 2 Table 2.1
partial safety factors recommended by the Eurocode;

Numerical values for safety factors may be defined in the National Annex

Bolt design strength

$f_{yd} = f_y / \gamma_{M2}$

f_{yd} = 818.2 N/mm^2

Bolt design tension resistance

$F_{t,Rd} = f_{yd} * A_s$

$F_{t,Rd}$ = 128.45 kN

Bolt design preload

$F_{p.Cd} = 0.7 * f_{ub} * A_s / \gamma_{M7}$

$F_{p.Cd}$ = 99.91 kN

per EN 1993-1-8
Section 3.6.1 Formula (3.1)
for preloaded bolts in accordance with 3.1.2(1)
(i.e. only bolt assemblies of classes 8.8 and 10.9)

Torque reference values for bolt tightening

$M_r = k_m * d * F_{p,Cd}$

k_m = 0.2

per EN 1090-2
Section 8.5.2 Paragraph a) - 1) and 2)

k-class (K1 or K2) and k_m value declared by the fastener manufacturer

(normally k=0.2 for typical steel, k=0.2 for zinc-plated, k=0.18 for lubricated, k=0.16 for cadmium-plated)

M_r = 319.7 kN*m

torque value when the connection is slip ressistant

50 % * $F_{p.Cd}$ = 49.95 kN

per EN 1993-1-8
Section 3.4.2, Note:

If preload is not explicitly used in the design calculations for slip resistances but is required for execution purposes or as a quality measure (e.g. for durability) then the level of preload can be specified in the National Annex.

Torque value when there is no slip resistance specified in the design

$M_{r(non\ slip)}$ = 159.9 kN*m

value for 50 % of the bolt preload capacity

References:
EN 1090-2:2008 Execution of steel structures and aluminium structures - Part 2: Technical requirements for steel structures
EN 1993-1-8:2005 - Eurocode 3: Design of steel structures - Part 1-8: Design of joints