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Connecting with Your Buildings

Bolted connections in buildings are one of many imperative components of the building. In this Tips From Engineering article we will review the NBG drawing notes and reference materials that provide guidance for bolted connections, with an emphasis on Pretensioned Joints.

Excerpt from NBG drawings:

A325 & A490 BOLT TIGHTENING REQUIREMENTS:

IT IS THE RESPONSIBILITY OF THE ERECTOR TO ENSURE PROPER BOLT TIGHTNESS IN ACCORDANCE WITH APPLICABLE REGULATIONS. FOR PROJECTS IN THE UNITED STATES SEE THE RCSC SPECIFICATION FOR STRUCTURAL JOINTS USING [A325 OR A490 BOLTS] OR FOR PROJECTS IN CANADA, SEE THE CAN/CSA S16 LIMIT STATES DESIGN OF STEEL STRUCTURES FOR MORE INFORMATION.

THE FOLLOWING CRITERIA MAY BE USED TO DETERMINE THE BOLT TIGHTNESS (I.E., "SNUG-TIGHT" OR "FULLY-PRETENSIONED"), UNLESS REQUIRED OTHERWISE BY LOCAL JURISDICTION OR CONTRACT REQUIREMENTS:

- A) ALL A490 BOLTS SHALL BE "FULLY-PRETENSIONED".*
- B) ALL A325 BOLTS IN PRIMARY FRAMING (RIGID FRAMES AND BRACING) MAY BE "SNUG-TIGHT", EXCEPT AS FOLLOWS: "FULLY-PRETENSION" A325 BOLTS IF:
 - a) BUILDING SUPPORTS A CRANE SYSTEM WITH A CAPACITY GREATER THAN 5 TONS.*
 - b) BUILDING SUPPORTS MACHINERY THAT CREATES VIBRATION, IMPACT OR STRESS-REVERSALS ON THE CONNECTIONS. THE ENGINEER-OF-RECORD FOR THE PROJECT SHOULD BE CONSULTED TO EVALUATE FOR THIS CONDITION.*
 - c) THE PROJECT SITE IS LOCATED IN A HIGH SEISMIC AREA. FOR IBC-BASED CODES, "HIGH SEISMIC AREA" IS DEFINED AS "SEISMIC DESIGN CATEGORY" OF "D", "E", OR "F". SEE THE "BUILDING LOADS" SECTION OF THIS PAGE FOR THE DEFINED SEISMIC DESIGN CATEGORY FOR THIS PROJECT.*
 - d) ANY CONNECTION DESIGNATED IN THESE DRAWINGS AS "A325-SC". "SLIP-CRITICAL (SC)" CONNECTIONS MUST BE FREE OF PAINT, OIL, OR OTHER MATERIALS THAT REDUCE FRICTION AT CONTACT SURFACES. GALVANIZED OR LIGHTLY RUSTED SURFACES ARE ACCEPTABLE.**
- C) IN CANADA, ALL A325 AND A490 BOLTS SHALL BE "FULLY PRE-TENSIONED", EXCEPT FOR SECONDARY MEMBERS (PURLINS, GIRTS, OPENING FRAMING, ETC.) AND FLANGE BRACES.*

SECONDARY MEMBERS (PURLINS, GIRTS, OPENING FRAMING, ETC.) AND FLANGE BRACE CONNECTIONS MAY ALWAYS BE "SNUG-TIGHT", UNLESS INDICATED OTHERWISE IN THESE DRAWINGS

What reference materials are available for erectors?

For United States projects, the Research Council on Structural Connections (RCSC) has published a specification called Specification for Structural Joints Using High-Strength Bolts, available at the Bolt Council website here: <https://www.boltcouncil.org/>

The RCSC specification is referenced in the AISC Steel Construction Manual.

For Canadian projects, the Canadian Standards Association (CSA) has published information in S16 Design of Steel Structures.

What is a snug-tight connection?

Snug-tight is the precursor to a pretensioned connection and may be the acceptable method of making a finished connection. The RCSC and CSA provide the definition of achieving a snug-tight joint.

What is a pretensioned connection?

Pretensioned connections are when a specific amount of tension is put into the bolts during erection. By putting this tension into the connection, the connection is less likely to loosen over its life span due to vibration, as well as achieve the required strength intended by the design.

A good example of this in everyday life are the lug nuts on the wheels of a vehicle. The vehicle manufacturer has specified a precise Torque required to hold the wheels to that vehicle. When the torque is not properly applied, there's a chance that the wheels will come off the vehicle.

Why doesn't the specification tell me how much Torque is required?

The simple answer is that Torque and Tension are not synonymous. Field conditions could cause variations in the required Torque.

Both the RCSC and CSA specification have requirements on proper storage of fasteners and methods of testing prior to installation. Through proper testing, the required Torque can then be determined in the field.

What methods are available for Pretensioned Connections?

1. Turn-of-Nut Pretensioning
2. Calibrated Wrench Pretensioning (**Not included in CSA S16**)
3. Twist-Off-Type Tension-Control Bolt Pretensioning
4. Direct-Tension-Indicator (DTI) Pretensioning

The bolted connection specifications in the RCSC and CSA are critical to the performance and safety of structures. *The RCSC is available as a free download from their website and the CSA is a purchasable document.*