

2014 FAA Worldwide Airport Technology Transfer Conference



S10016: Safely Secure Fasteners in Critical Applications

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The Benefits of Bolted Joint Assembly



- Ability to easily and quickly remove and reassemble
- Possible to join multiple clamped parts
- Suitable for assembly line production
- Flexible for many connection types
- All components are highly standardized
- Widely accepted method and readily available

Bolt securing has been a problem
since the bolt was invented





August 20, 2007 with China Airlines Flight 120, Boeing 737-800, flight from Taiwan Taoyuan International Airport to Naha Airport, Okinawa. Photos show the aftermath of improperly assembled downstop assembly nut on the leading edge slats which caused a fuel leak from the wing.

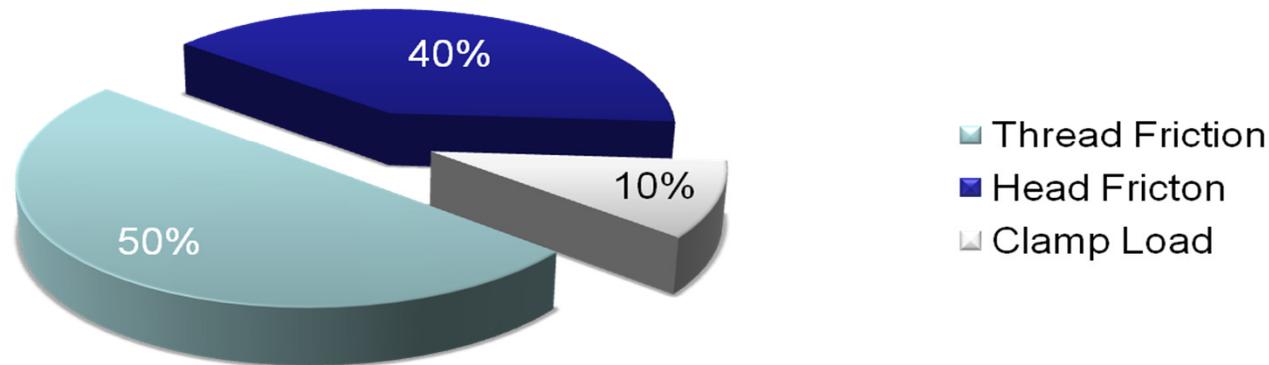
Bolt Loosening Principle

When fastening a bolted joint, a moment is usually required for a threaded joint. The tightening moment (M_A) can be represented into three components (i.e., in Blume, Illgner 1988):

$$M_A = M_{T,P} + M_{T,F} + M_{H,F}$$

Thread pitch Thread friction Head friction

Tightening Torque

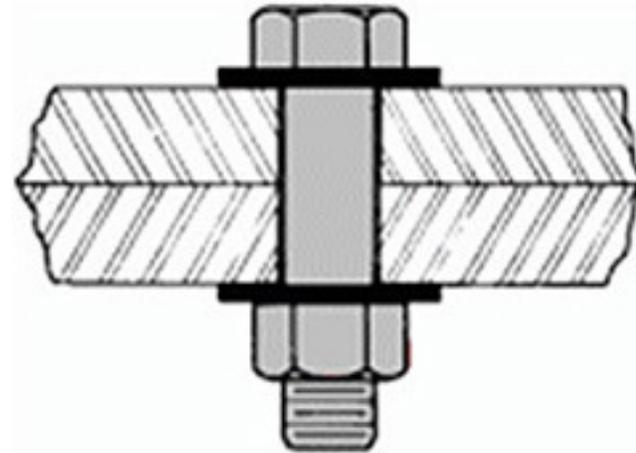


Bolt Loosening Principle

Untightening (Loosening) moment: $M_L = -M_{T,P} + M_{T,F} + M_{H,F}$

Where $M_{T,P} \leq M_{T,F} + M_{H,F}$

“Self-Locking”



Where $M_{T,P} > M_{T,F} + M_{H,F}$

“Self-Loosing”



Critical Displacement Threshold

The critical displacement threshold (d) can be calculated by:

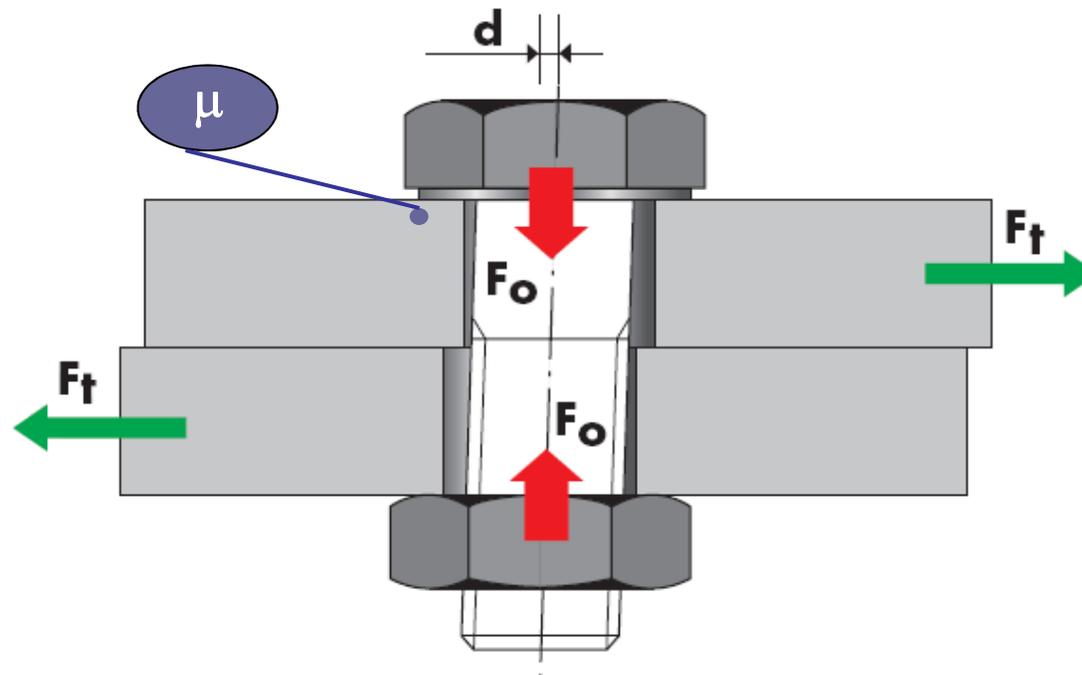
$$d = \frac{\mu * F_0 * (L_p)^3}{12 * E_b * I}$$

Where: F_0 : Preload of the bolt

μ : Friction coefficient under the head of the bolt

L_p : Clamp length of the bolt

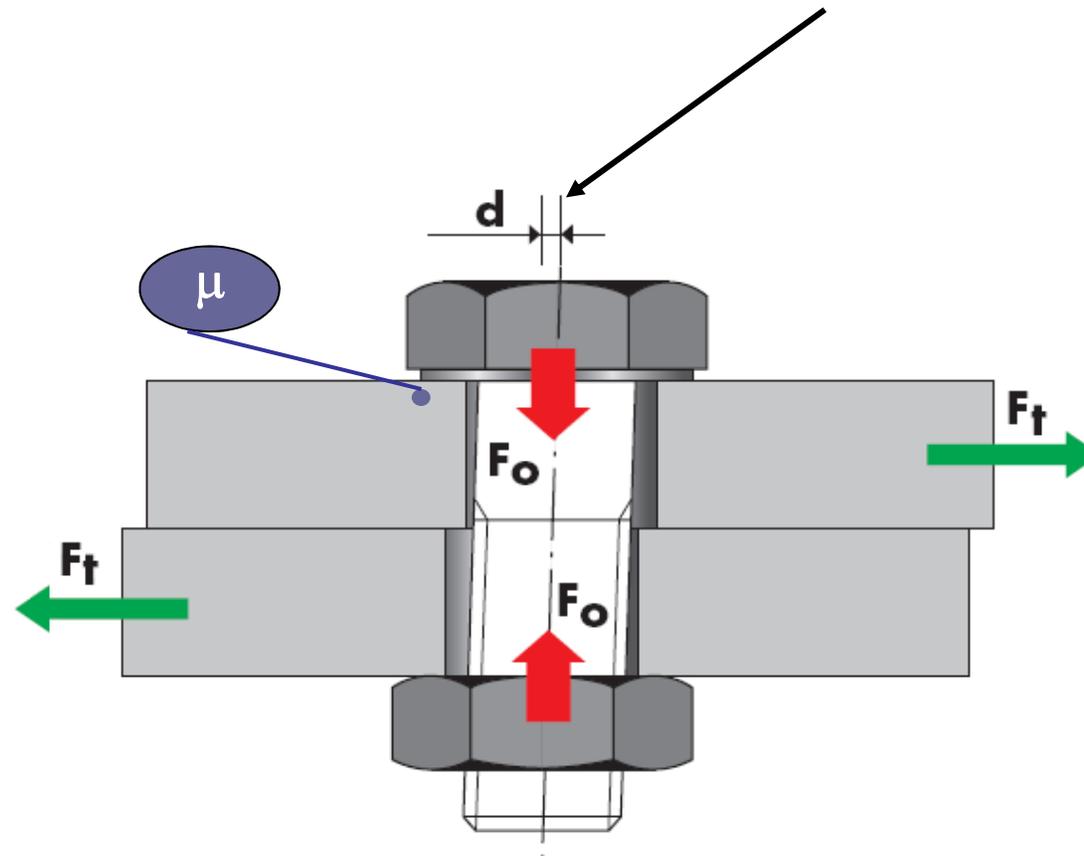
$E_b * I$: Stiffness of the bolt



Critical Displacement Threshold

Example: M10 grade 5 bolt preloaded to 30,000N (6744lbs) with a clamp length of 10mm and 0.15 friction coefficient under the head. (This preload stresses the bolt at 82% of its yield strength)

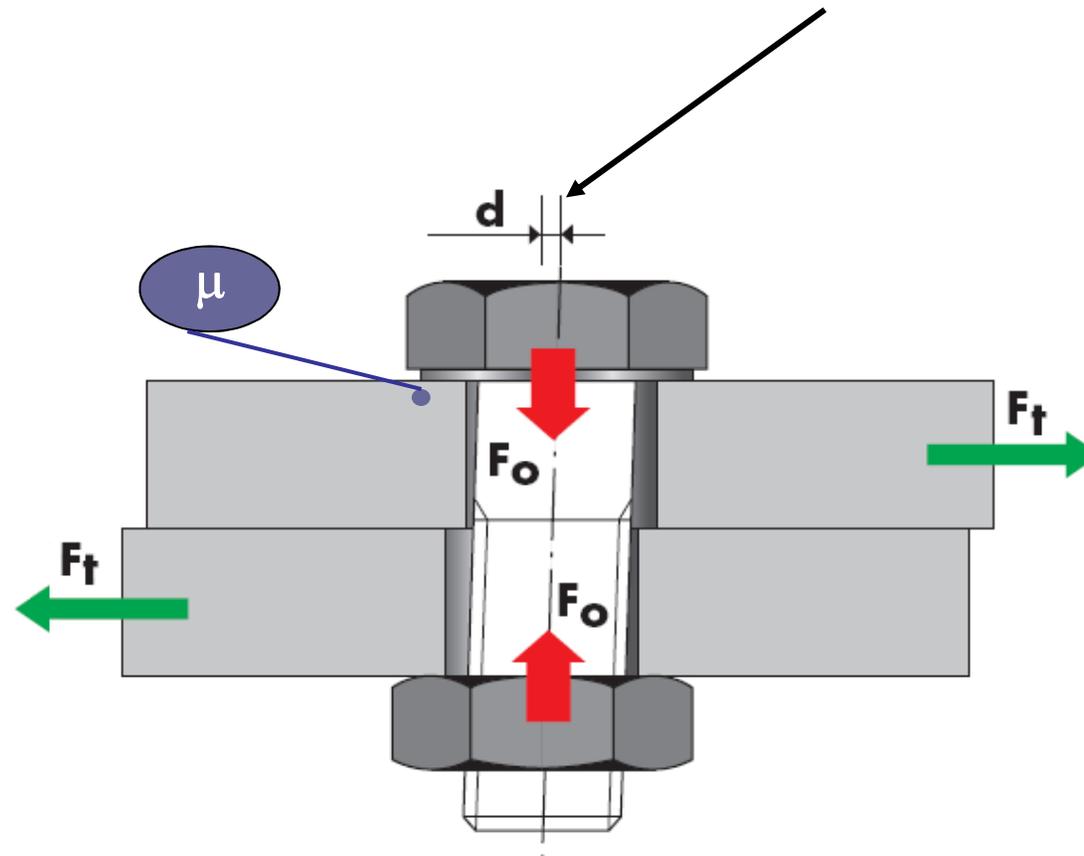
The critical displacement threshold (d) is ?:



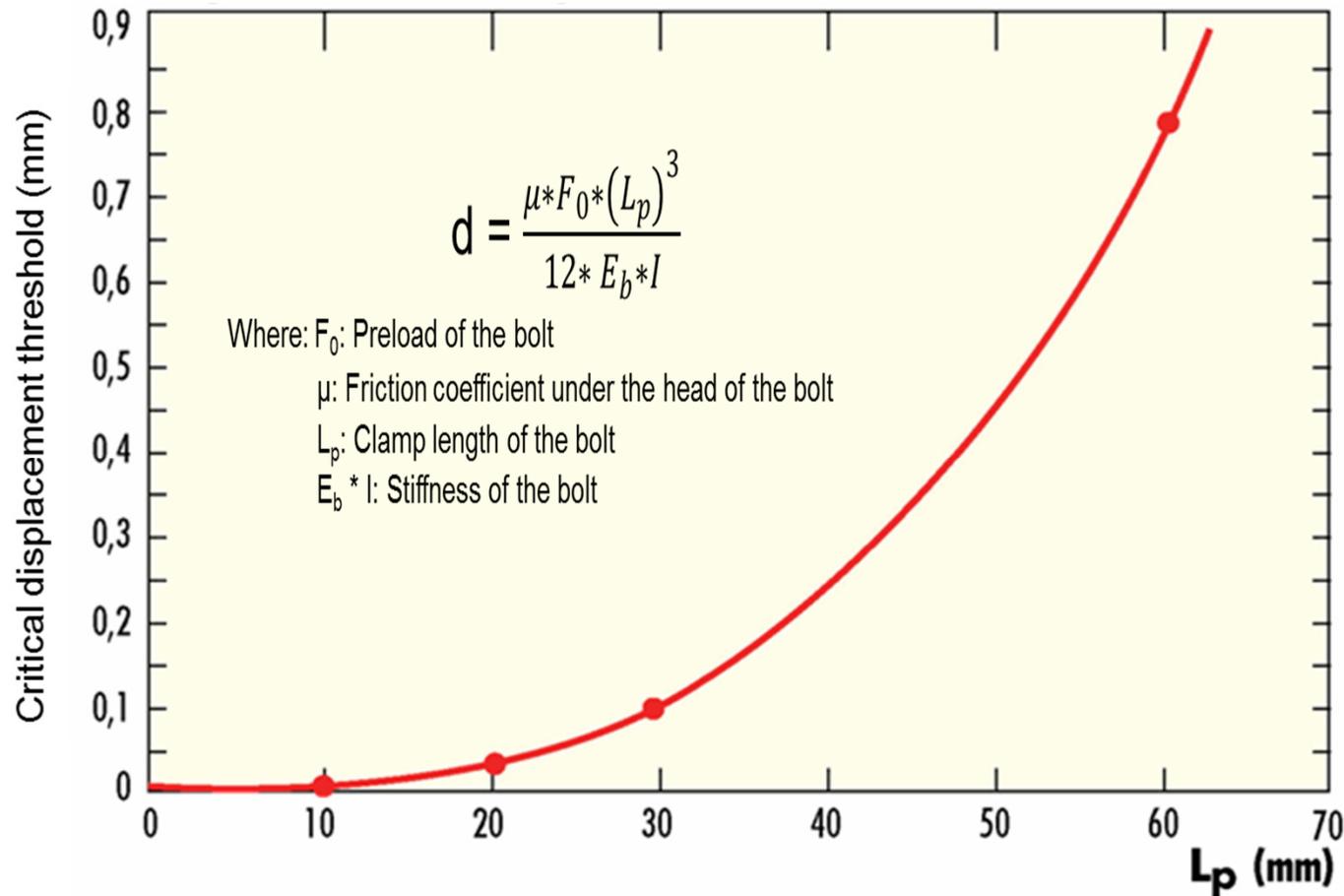
Critical Displacement Threshold

Example: M10 grade 5 bolt preloaded to 30,000N (6744lbs) with a clamp length of 10mm and 0.15 friction coefficient under the head. (This preload stresses the bolt at 82% of its yield strength)

The critical displacement threshold (d) is 0.004mm (0.00016"):

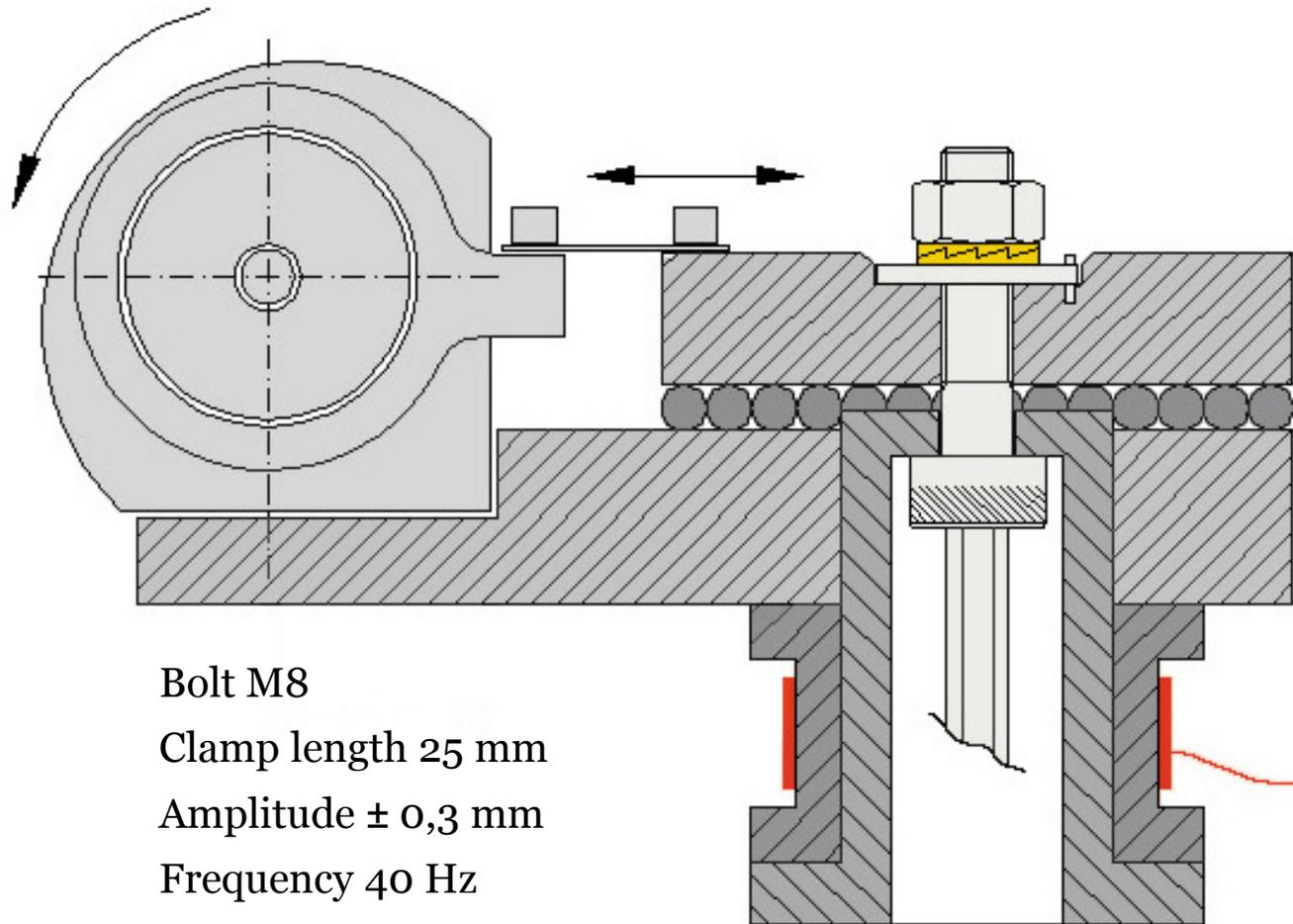


Critical Displacement Threshold vs. Clamp Length



Shows the benefit of increasing the clamp length on bolted joint to resist bolt self-loosening. Increasing the clamp length has an exponential relationship to enhancing the critical displacement threshold.

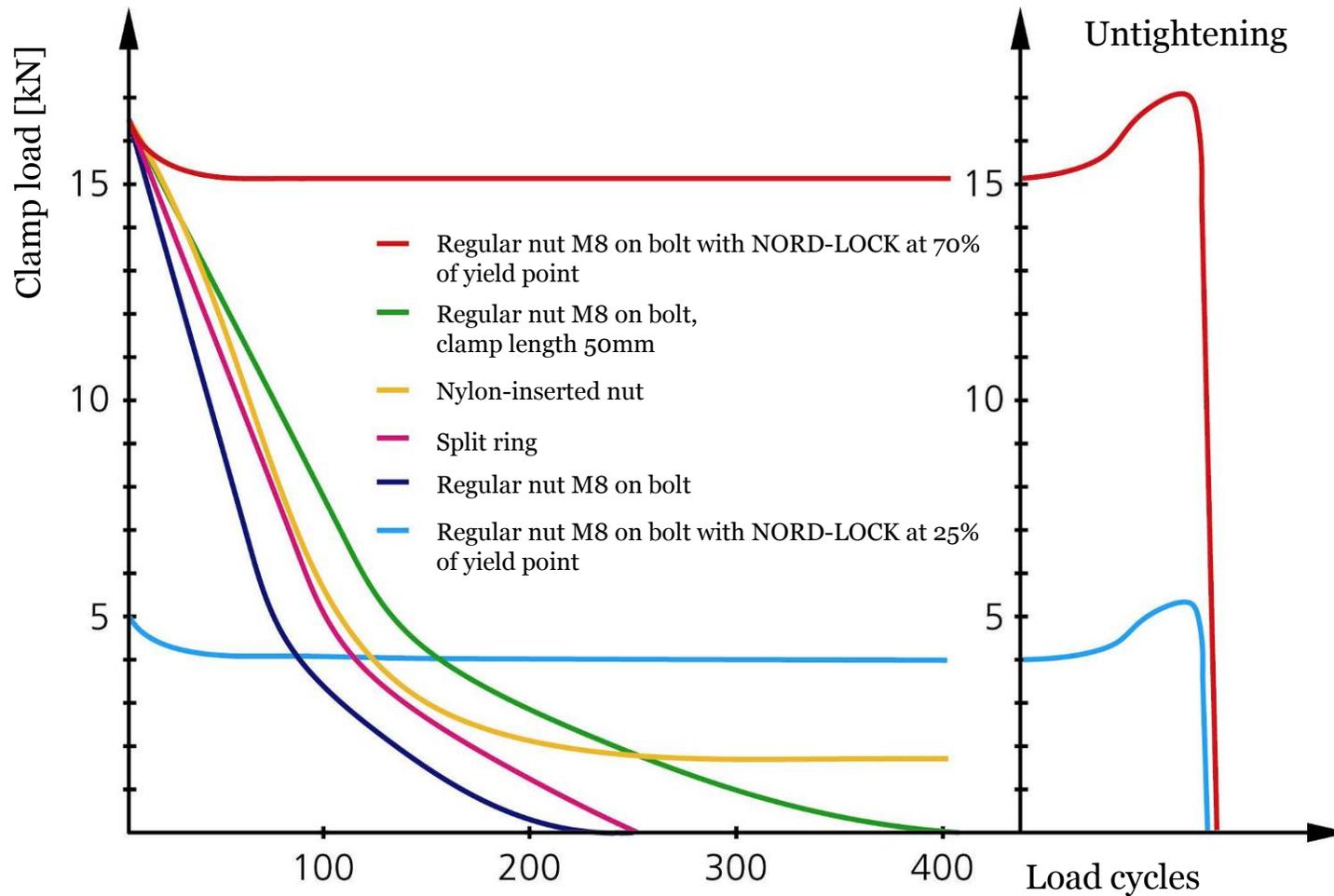
Junker Vibration Test – DIN 65151



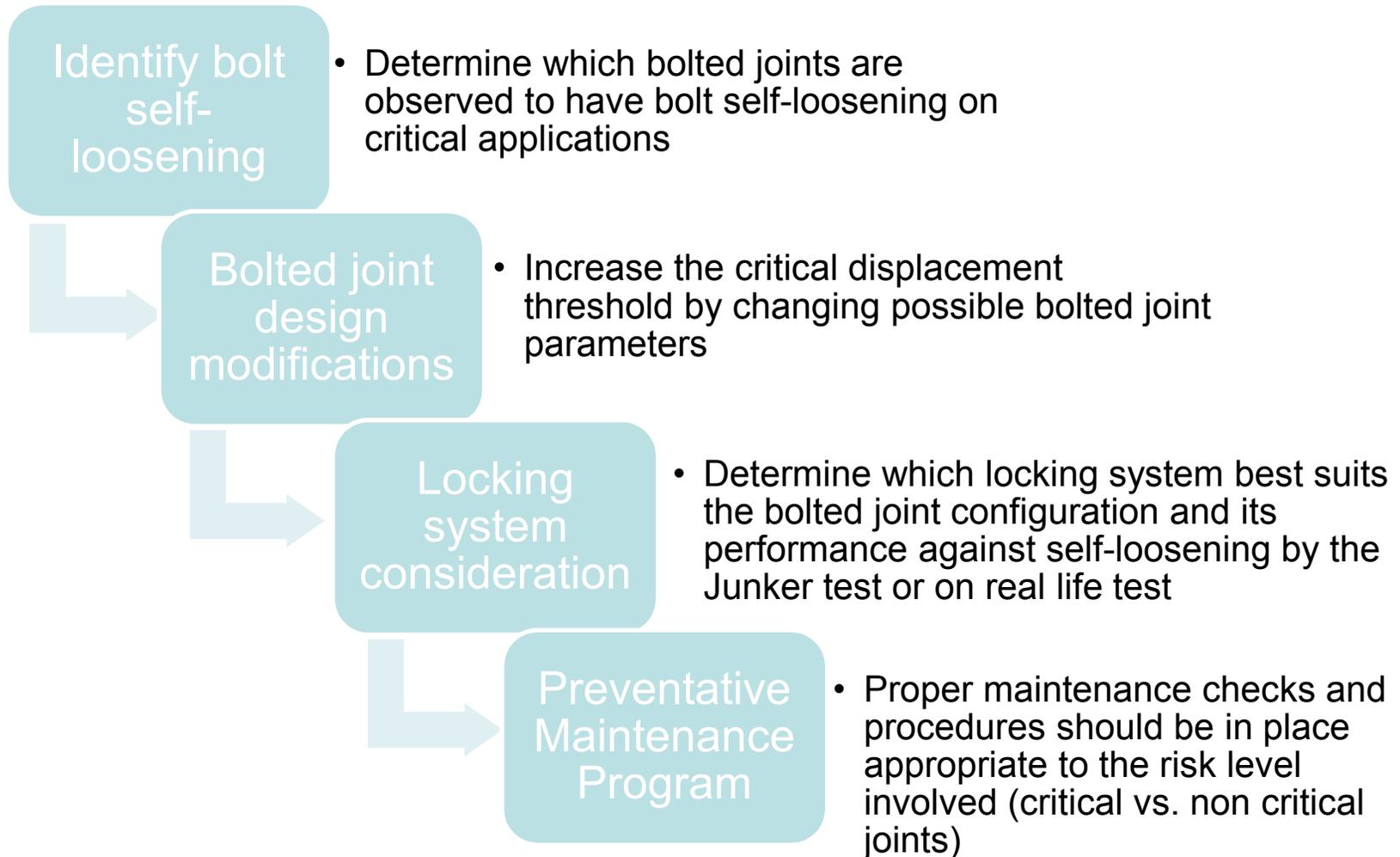
Bolt M8
Clamp length 25 mm
Amplitude $\pm 0,3$ mm
Frequency 40 Hz

Junker Vibration Test – Results

***Will be conducting a live Junker Test here and the results should be like shown below



Conclusion



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Thank you for listening!

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