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Testing fasteners for OEM certification

By Morten Schiff[1]

The Junker vibration test has become the standard for determining fasteners self-loosening behaviour under vibration. Testing procedures that reflect the real service conditions allow engineers to validate new bolted joints designs. If the purpose of testing is to certify fasteners to original equipment manufacturers (OEM) specifications or assess an insurance claim, ISO 16130, DIN 25201-4 B and DIN 65151 all provide standardised assessment of self-loosening behaviour under defined test conditions.

The table below compares the different approaches and criteria of the three testing standards.

	ISO 16130 The new standard for aerospace	DIN 25201-4, B The toughest conditions	DIN 65151 The former standard	The Vibrationmaster view
Hardware requirements				
Test washer	Yes, secured from rotation	Yes, secured from rotation. - Dimensions and roughness must comply to DIN EN ISO 7093-1 - Plane-parallelism and flatness must comply with DIN EN ISO 4759-3 - Hardness must be 200HV for fastener class up to 8.8 and 300HV for fastener class above 8.8 - Washers must be grounded		A specified test washer must be used with each test, to standardise embedding and ensure reproducible results.
Fastener adaptors	Yes, secured from rotation	Yes, secured from rotation		
Test Bench requirements				
Transverse displacement	Relative movement up to ±1.5mm for fasteners with dimensions up to 25.4mm / 1" UTS	Relative movement up to ±1.0mm shall be possible for fasteners with dimensions up to 24mm.		
	Infinitely variable, preferably during operation and adjusted through electronic control	Infinitely variable		
Test frequency	12.5Hz with a possible frequency range of 10Hz to 15Hz at an accuracy of ±3%	12.5Hz	12.5Hz	
Clamping force measurement uncertainty	±2% as measured on the entire measuring chain	±0,6% as measured on the entire measuring chain	±0,6% as measured on the entire measuring chain	
Transverse displacement measurement uncertainty	±3% as measured on the entire measuring chain	±3% as measured on the entire measuring chain	±3% as measured on the entire measuring chain	
Other tolerances	Clearance between stationary plate and glider plate must be 1mm ±0,05mm under load	Clearance between stationary plate and glider plate must be 1mm	Clearance between stationary plate and glider plate must be 1mm	
	Stationary plate and glider plate shall be concentric within ±0,1mm	Stationary plate and glider plate shall be concentric	Stationary plate and glider plate shall be concentric	
Test settings and requirements				
Measured variables	Maximum self-locking torque			Only ISO includes a range of torque measurement in the test – we believe this makes ISO the most useful.
	Necessary tightening torque value to achieve initial clamping force			
	Initial clamping force	Initial clamping force		
	Clamping force during test relative to cycles	Clamping force during test relative to cycles	Clamping force during test relative to cycles	
		Transverse displacement under load		
	Maximum self-locking torque after vibration test			
	Testing temperature			
Reference test to assess the effective displacement	Assess the effective displacement that makes an unsecured joint self-loosen within 300 cycles ±100 cycles	Assess the effective displacement that makes an unsecured joint self-loosen within 300 cycles ±100 cycles		
Verification test	Verification tests (3x) must be completed	Verification tests (12x) must be completed with a duration of 2,000 cycles or until complete loss of clamping force		3 tests should be sufficient with good test equipment delivering reproducible results.

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Test settings and requirements				
Reuse of fasteners	Allowed if parts are not visually damaged.	No		Pre-stressed elements should NEVER be allowed to be reused. A fastener that has been used will be elongated and may have exceeded its yield strength and changed material properties.
Initial clamping force	75% of calculated ultimate clamping force	50% of VDI 2230 with µtot total coefficient of friction = 0.14		
Clamp ratio (fastener length to diameter ratio)	As short as possible and preferably around 1:2.0 to 1:2.5	1:1.7		The clamp ratio is very important when testing. The lower the ratio, the greater risk of self loosening. This is particularly important in view of current trends to use short fasteners.
Use of lubrication		Yes. SAE30 for steel parts and molybdenum sulphide paste for stainless or electro-galvanized parts		Lubricating the fasteners is important to obtain reproducible friction values and test results.
Test evaluation and reporting				
Evaluation method	- Number of cycles until complete loss or, - Residual clamping force following a defined number of cycles or, - Number of cycles until fatigue fracture of the bolt	Residual clamping force after 2,000 cycles		
Evaluation of self-locking behaviour	- 100% to 85% residual preload = Good self-locking behaviour. - 85% to 40% residual preload = Acceptable loss of preload. - 40% to 0% residual preload = Poor self-locking behaviour	100% to 80% residual clamping force after 2,000 cycles = adequate self-locking behaviour		The residual preload is crucial – 60% loosening cannot be acceptable – the DIN approach is more rigorous.
Test report requirements	All test parameters, information about the tested fastener system, test bench manufacturer and model, fasteners used, name of testing laboratory, date of testing, inspector name, lot number of the tested fasteners	- The test fittings used (number, dimensions, material designations, surface designations, quality categories, type of securing element, fitting position) - The test parameters (test frequency, clamp ratio, clamping force, effective transverse displacement, lubrication) - Test bench manufacturer and model - The result of the test including graph of clamping force against cycles - The permissible usage of the securing element		

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Our solutions include materials and fasteners vibration testing machines that help our customers develop more reliable and safer products.

Equipment manufacturers integrate our adaptable electro-mechanical actuators and control systems into their designs to reduce and eliminate vibration in a wide range of applications, from wind turbines to automotive, rail, aerospace, industrial and consumer products.

Our partners enjoy customised technical solutions, products and services.

Innovation is at the heart of our organization, as we are constantly looking for new ways to help our customers and our partners move forward.

Together, we can build a safer world.
We are the Vibrationmaster.

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