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HIGH STRENGTH STRUCTURAL BOLT ASSEMBLIES TO AS/NZS 1252:2016

SUMMARY

Currently all high strength structural bolts manufactured to AS/NZS 1252 are imported into Australia by a number of importers/distributors. Market pressure to reduce the cost of steel packages has resulted in global sourcing from regions with varying levels of quality assurance for manufacture of structural bolt assemblies. Consequently, there has been a demonstrable issue with the quality and compliance of structural bolt assemblies in Australia over the past years.

This Technical Note outlines the technical basis for and implementation of the latest 2016 revision of AS/NZS 1252 (Ref. 1), specifically designed to facilitate improved compliance outcomes for high strength bolts for the Australian marketplace. The revision to AS/NZS 1252 was undertaken by Standards Committee ME-029. The Standard has now been published in two parts:

- AS/NZS 1252 High-strength steel fastener assemblies for structural engineering – Bolts, nuts and washers: Part 1 – Technical requirements
- AS/NZS 1252 High-strength steel fastener assemblies for structural engineering – Bolts, nuts and washers: Part 2 – Verification testing for bolt assemblies

CONTEXT

Historically, fastener quality has been one of the most overlooked aspects in construction and manufacturing in Australia, a complacency no doubt rooted in 100 years of relying on Australian manufacturers to supply fit-for-purpose product manufactured to Australian Standards. Significantly, with local manufacture comes compliance to local consumer laws and a legal system that can reach any wayward manufacturers.

In the last 15 years, fundamental changes in our procurement environment, with increased competition and, unfortunately, demonstrable cases of reduction in quality, have resulted in virtually all local manufacturing ceasing and importation of the majority of structural bolts. Whilst quality product can undeniably be sourced internationally, it is also true that ‘quality costs’ and market pressure to reduce the cost of steel packages has resulted in predominantly price driven competition, where quality is demonstrated by a certificate whose veracity and/or appropriateness may be questionable. With legal recourse problematic and costly internationally, it is often left to a local party, usually the engineer, to ‘certify’ that the product meets the performance requirements of our Standards.

Assessing the compliance of construction products, even something as seemingly simple as a high strength structural bolt assembly, is actually far from trivial and usually involves an understanding of the manufacturing regime and reliance on various documents from the manufacturer. Experience has shown that the veracity of these documents can vary markedly, from complete disclosure of all tests and information, to documents often missing required information, through to demonstrably fraudulent documentation. In parallel, the actual performance of the bolt assemblies can vary from largely compliant through to woefully inadequate.

To add to the issues related to cost pressure, there are also a number of issues related to AS/NZS 1252. The previous AS/NZS 1252:1996 (Ref. 2) was developed under a more forgiving procurement environment. With the changes in procurement environment noted above, the compliance requirements in AS/NZS 1252:1996 became inadequate, presenting loopholes utilised by parties interested only in the cost dimension of supply (Refs 3, 4). The closure of local manufacture, with the ensuing reduction in local technical expertise in fasteners, has exacerbated the issue.

Bolts manufactured to AS/NZS 1252:1996 are, in some respects, unique to the Australian market. Whilst in many respects they have performance requirements similar to bolts manufactured to other Standards, differences such as head markings and some minor geometrical characteristics necessitate that manufacturing is set up specifically to suit these bolts. ‘Boutique’ Australian manufacturing requirements and a comparatively small volume market do not engender economies of scale or a particular focus from the large bolt manufacturers typically located in China. Consequently, our importers face continual challenges to maintain focus and compliant supply from manufacturers.

To address the issues noted above, ASI has championed the development of a (long overdue) revision to AS/NZS 1252, as detailed in this Tech Note.

ISSUES IN RELATION TO AS/NZS 1252:1996

As noted above, it is important to understand the issues with the previous AS/NZS 1252:1996 to provide context for the changes implemented in AS/NZS 1252:2016. The issues include:

(1) There were no provisions in the Standard for the minimum requirements of a certificate of compliance.

(2) Appendix A (Sampling Plan) was ‘Informative’ rather than ‘Normative’, thus resulting in there being no minimum testing requirements.

(3) Appendix C of AS/NZS 1252:1996 contained a method of testing the anti-seizing properties of an assembly of high-strength steel bolts and nuts with corrosion-preventative coatings such as galvanizing. This test was for a test assembly consisting of bolt/nut/washer. This Appendix was also only ‘Informative’ rather than ‘Normative’.

(4) Notwithstanding the informative assembly test noted above, there was no actual reference in AS/NZS 1252:1996 to preloading or tensioned application.

(5) There were issues with AS/NZS 1252:1996 peculiar to the Australian market.

   (a) M20 bolts were not readily available to AS/NZS 1252:1996 dimensions due to ISO 7411 not being adopted internationally. M20 bolts were being supplied to AS 1252:1983 for dimensions and to AS/NZS 1252:1996 for materials and mechanical properties, which in turn calls up AS 4291.1:2000 (Ref. 6) for the properties. This added some complexity when checking whether M20 bolts comply with the Standard.

   (b) The hardness requirement in AS/NZS 1252:1996 for hot-dipped galvanized washers was lowered to 26HRC. The specified hardness range for Property Class 8.8 in AS 4291.1—2000 is 23-34HRC. It was recommended for fastener supply over the last 20 years that washers be manufactured with 35-45HRC (as was required in AS/NZS 1252:1996 for other than hot-dipped galvanized washers) in order to avoid scouring of the washers when bolts are tensioned.

THE NEW AS/NZS 1252:2016

Overarching Principles

In developing the remit for a revision to the twenty-year-old AS/NZS 1252:1996, a number of overarching principles guided the desired outcomes:

- For mass-produced items such as fasteners, quality and cost effectiveness would always be challenging for a relatively small market such as Australia if the product was unique to Australia and procurement pressure dictated overseas supply. It was therefore considered highly desirable to move towards a bolt specification that was aligned with a significant global supply.

- Accepted practice is difficult to change and can be dislocating, in particular where existing product supply is well developed and commercial pressures are significant. Notwithstanding the identified need to move towards internationally aligned supply, the process to reach that point needed to be managed, to allow all stakeholders time to make necessary changes and also, importantly, to provide time for feedback on changes, to ensure the results were consistent with expectations.
- Any changes needed to be consistent with the fundamental design principles outlined in AS 4100 (Ref. 5), whilst ideally also allowing for desired outcomes from an expected significant revision to AS 4100 in due course.
- In the current procurement environment, the definition of compliant product needed to be both clarified and strengthened.
- Whilst product conformity (as defined by the Standard) may be clarified, a significant issue in today's procurement environment is actually assessing whether a product meets the product conformity requirements, given the demonstrable shortcomings, including deliberate fraud, noted earlier. Procurers generally do not have the time or technical expertise necessary and often simply do not appreciate the rigour necessary for conformity assessment. Therefore, it was considered vital to provide tools to help industry assess product conformity expediently and cost effectively.

The following sub-sections outline the main revisions to AS/NZS 1252 that action the above principles, noting that AS/NZS 1252:2016 is now in two parts, AS/NZS 1252.1 and AS/NZS 1252.2.

AS/NZS 1252.1 – Dimensional changes and designation

Certain dimensions, in particular the across flat dimensions of the M20 bolt and nut have been reinstated from the 1983 edition of AS 1252, for consistency with available supply and to address the anomaly in M20 dimensions noted previously. This change also aligns these dimensions with those of the EN 14399-3 'alternative assembly type' discussed subsequently.

Other minor dimensional changes were made to align with ISO requirements.

The characteristics for an M12 bolt assembly have been defined, as these bolt assemblies are available in the market.

Designation of high strength Property Class 8.8 bolt assemblies has not changed from the previous version of AS/NZS 1252.

AS/NZS 1252.1 – Bolt assembly functional characteristics

One of the significant shortcomings of the previous AS/NZS 1252 was the lack of definition of the performance requirements of the bolt assembly, comprising the bolt, nut and washer acting together. AS/NZS 1252:1996 made the tacit assumption that if each of the components was within specification, the assembly should perform as expected as a pre-tensioned assembly. In an internationalised manufacturing environment with each component produced in separate factories (and potentially subject to cost reducing shortcuts) and no clear responsibility for the performance of the finished assembly, it is perhaps not unexpected that these clearly evident problems have manifested themselves.

AS/NZS 1252.1:2016 has introduced a new Section 5 defining the functional characteristics of the bolt assembly, including minimum bolt tension force and minimum nut rotation requirement. In addition, an (optional) specific relationship between torque and tension has been defined.

AS/NZS 1252.1 – Torque-tension relationship for tightening of bolt assemblies

Currently AS 4100 (and the new AS/NZS 5131 (Ref. 7)) calls up two methods for tensioning of bolt assemblies, either the part-turn method of tensioning, or the use of a direct tension indicator device (DTI). Other forms of tightening are not specifically addressed, although both AS 4100 and AS/NZS 5131 do not exclude their use.

Using a torque wrench to tighten bolts to a defined tension is accepted practice in both Europe and America. However, this approach does require a known and reproducible relationship between torque applied to the bolt and the resulting tension, which can be significantly affected by bolt properties such as thread engagement and coating. Historically, in the Australian marketplace and in particular with regard to both our significant adoption of galvanized bolts and issues with compliant supply, there has not been the confidence with torque controlled methods of tightening.

There is an expectation that with the revision to AS/NZS 1252, including significant focus on ensuring compliant supply, the market will respond positively and we will get improved compliance and bolt assembly performance. This then opens the door to confidence that we will be able to procure bolt assemblies with a reliable torque-tension relationship.

AS/NZS 1252.1 defines a relationship between torque applied to the nut (or bolt) and the tension developed in the bolt assembly given by:

$$M_{r,i} = k_m \, d \, F_{p,C}$$

where:

$M_{r,i}$ = torque required to develop minimum bolt tension $F_{p,C}$

k_m = k_m for k-class K1 or K2 as appropriate

d = nominal diameter of the bolt

$F_{p,C}$ = minimum bolt tension (preload) defined in the relevant Standard

The value of k_m for the so-called ‘k-class’ of K1 or K2 is established by the ‘extended assembly test’ outlined in Appendix D of AS/NZS 1252.1. Bolt assemblies for which this testing has not been undertaken and therefore cannot be used for torque controlled methods of tensioning are termed k-class K0. Note however that K1 or K2 assemblies can be used in a K0 application, utilising the K0 installation methodology.

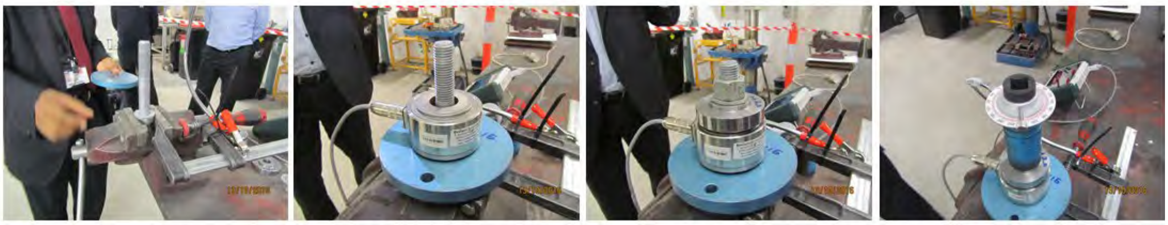
The usual high strength structural bolts supplied in Australia have been effectively k-class K0. The difference between k-class K1 and K2 lies in the tighter control over the variability of the k-value with k-class K2.

AS/NZS 1252.1 – Bolt assembly test

Arguably the most fundamental test to establish bolt assembly performance is the ‘bolt assembly test’, which essentially demonstrates the bolt assembly can be tightened to meet the required minimum tension. Many of the issues discussed above with regard to non-compliance of the bolt assembly components result in bolt assemblies that do not meet the expected assembly performance, usually through failure in tension, rotation induced torsion or thread stripping. As noted above, in AS/NZS 1252:1996, the assembly test detailed in Appendix C was ‘informative’ and consequently in most cases was only mandated by informed procurers who understood the benefits of the test.

AS/NZS 1252.1 introduces two forms of assembly test:

(a) The ‘**Basic assembly test**’: along with the usual range of tests required for factory production control, the basic assembly test comprises a bolt/nut/washer assembled in a load cell. The assembly is tensioned by rotating the nut (or bolt if specified) until the tension in the bolt reaches 0.7 times the ultimate failure load of the bolt. This point is



(a) M20 bolt in vice (b) With load cell in place (c) With nut and washer assembled (d) Fully assembled with socket and rotation measuring device

FIGURE 1 – BESPOKE BASIC BOLT ASSEMBLY TEST

defined as the datum. The nut (or bolt) is further rotated from the datum to achieve minimum required values of nut rotation and tension in the bolt. There is no requirement to measure applied torque. Figure 1 illustrates the simplicity of the assembly arrangement for a bespoke basic assembly test. Production versions of the test would likely be better systemised.

(b) The ‘**Extended assembly test**’: in addition to the basic assembly test, the extended assembly test adds measurement and graphing of data points throughout the test extent and measurement of applied torque, sufficient to allow graphing of results and assessment of the torque-tension relationship to establish the value of k_m for k-class K1 or K2 bolt assemblies.

In the short to medium term, it is expected the majority of high strength bolts supplied to the Australian marketplace will only require the basic assembly test (k-class K0), as tensioning of these bolts will be undertaken using either the part-turn method or direct tension indicator device method, as is current practice.

Longer term, or for specific clients, there may be market demand for the use of torque controlled methods of tensioning, in which case the bolt assemblies will need to be tested to the extended assembly test and the K-class documented. As the torque-tension relationship provided by K1, K2 class is dependent on the exact surface condition of the fastener assembly during the certification testing, attention must be given to maintain the stock, assuring the surface condition is not affected in any way, for example, by keeping product dry and away from any impurities affecting the surface condition.

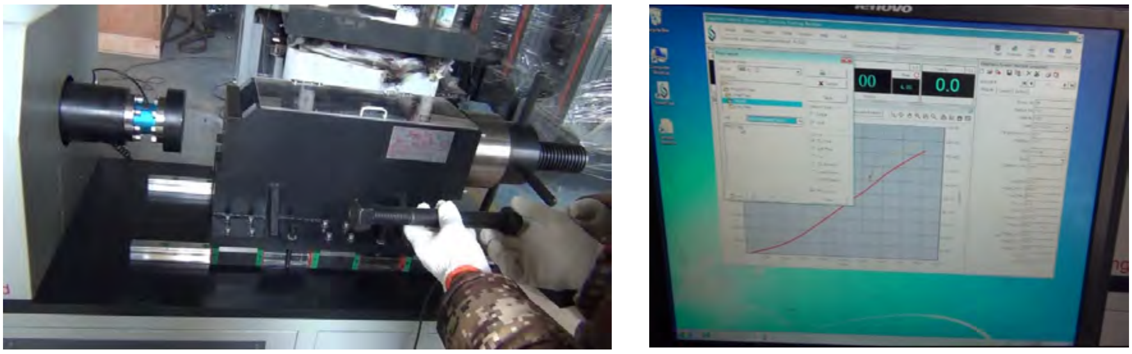


FIGURE 2 COMMERCIAL TEST EQUIPMENT AND OUTPUT FOR EXTENDED ASSEMBLY TEST

AS/NZS 1252.1 – Identification, certification and testing

Given the importance of rigorously defining product conformity, AS/NZS 1252.1 has introduced a new Section 6 on identification, certification and testing. The section covers:

(a) The required identification of the product on packaging and the like

(b) The extent and form of testing and test reports required

(c) The requirement for a declaration of conformity from the manufacturer

AS/NZS 1252.1 – Product conformity

AS/NZS 1252.1 has introduced a new Appendix B titled ‘Product Conformity’, which defines the minimum sampling and testing plans required to demonstrate product conformity by the manufacturer as part of initial type testing (ITT) and factory production control (FPC). The documentation required to be maintained and the treatment of non-conforming product is also covered.

AS/NZS 1252.1 – Purchasing guidelines

It is increasingly evident that the internationalised procurement environment has significantly complicated the understanding of what should be specified when procuring construction products, including high strength bolts. A loose specification can potentially result in misunderstanding and/or opportunistic supply of product not meeting the intended performance requirements. Consistent with our steel product Standards (Refs 8, 9, 10, 11), AS/NZS 1252.1 has introduced a new Appendix C titled ‘Purchasing Guidelines’, which documents the expected information to be supplied by the purchaser.

AS/NZS 1252.1 – Alternative assembly type to EN 14399-3 System HR

It is the documented intention of the ME-029 Standards Committee that high strength bolt supply for Australia moves towards international alignment, to provide liberalised choice of manufacturing options for our importers/suppliers and improved compliance outcomes. After extensive review and evaluation of alignment options, the committee chose alignment with Euronorm Standards, and in particular EN 14399-3 (Ref 12) as appropriate for the Australian market, with bolts closely aligned in terms of performance characteristics with our existing AS/NZS 1252 product.

Consequently, AS/NZS 1252.1 has nominated high strength structural bolt assemblies for preloading that are manufactured in accordance with EN 14399-3, System HR, Property Class 8.8 as the only ‘alternative assembly type’ that is deemed to satisfy the requirements of AS/NZS 1252.1. In effect, bolts to EN 14399-3 System HR may be supplied as equivalent where reference is made to bolt assemblies conforming to AS/NZS 1252.1.

Appendices A, B and C provide a comparison between the significant geometrical characteristics of bolts and nuts to AS/NZS 1252.1 and EN 14399-3 System HR and plain washers to AS/NZS 1252.1 and EN 14399-5. The geometrical characteristics are tabulated directly in each of the respective Standards, excepting for plain washers where EN 14399-5 is applicable.

Geometry:

In general, apart from some small differences in the fillet details under the bolt head, the bolt geometry is identical. Nut geometry is also identical, except that the EN 14399-3 System HR nuts are slightly thinner than the AS/NZS 1252.1 nuts. Historically, AS/NZS 1252 has adopted the ‘heavy hex’ nut variant. There are small differences in geometry for plain washers. Note also that AS/NZS 1252.1 requires the washers to be identified with three radial nibs on the outer circumference. There is no such requirement in EN 14399-5. Washers to EN 14399-6 are also slightly different to AS/NZS 1252.1 washers in having a chamfer on the internal diameter, for use either under the bolt head or nut.

In respect of the thread geometry, AS/NZS 1252.1 calls up the ISO coarse pitch series in accordance with AS 1275, which defined thread geometry to ISO 261. EN 14399-3 calls up ISO 261 for thread geometry. Both Standards nominate tolerance class 6g. Hence the thread geometry is identical in both Standards.

Material properties:

In respect of the bolt material and mechanical properties, AS/NZS 1252.1 calls up property class 8.8 to AS 4291.1. AS 4291.1 is a direct copy of ISO 898-1. EN 14399-3 System HR calls up EN ISO 898-1 directly. Hence the bolt material properties between the two Standards are identical. Similarly, for nuts, AS/NZS 1252.1 calls up property class 8 to AS 4291.2. AS 4291.2 is a direct copy of ISO 898-2. EN 14399-3 System HR calls up EN ISO 898-2 directly. Hence the nut material properties between the two Standards are identical.

In respect of washer material and mechanical properties, AS/NZS 1252.1 specifies hardened and tempered washers with a hardness of 320-390 HV (33-41 HRC), irrespective of whether the washers have plain finish or are hot-dip galvanized. In the previous version of the Standard, hot-dip galvanized washers were permitted to have a slightly reduced lower limit of 270 HV (26 HRC). However, there were some reports of gouging of the face of washers during tensioning at the lower hardness, especially when using DTI’s, and hence the lower limit was raised slightly in the

2016 revision. EN 14399-5 calls up hardened and tempered washers to EN ISO 4759-3 with a hardness range of 300 HV to 370 HV.

Designation:

Designation of bolt assembly components to EN 14399-3 System HR (for bolts, nuts) and EN 14399-5 (for plain washers) is indicated in Figure 3 and illustrated in Figure 4.

Failure modes:

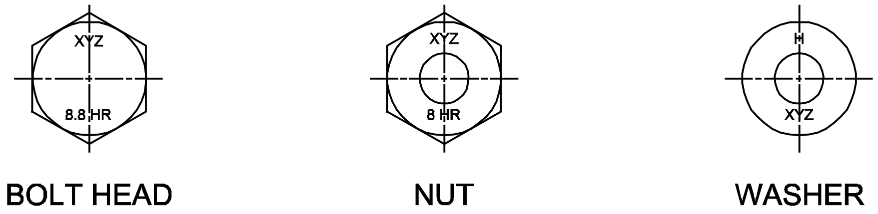


FIGURE 3 DESIGNATION OF EN 14399-3 SYSTEM HR PROPERTY CLASS 8.8 BOLT ASSEMBLIES

FIGURE 4 EN 14399-3 SYSTEM HR PROPERTY CLASS 8.8 BOLT ASSEMBLIES

It is important to understand the significance of the ‘System HR’ designation, as the EN 14399 series of Standards introduced two parallel systems for achieving the necessary ductility in tensioned (‘preloaded’) bolt assemblies, the ‘System HR’ (British/French) and the ‘System HV’ (German), largely a response to the two approaches implemented in Europe at the time.

System HR uses thick nuts and long thread lengths in the bolt assembly to obtain ductility through predominantly plastic deformation of the bolt, with eventual tensile failure of the bolt shank. In contrast, System HV uses thinner nuts and shorter thread lengths to obtain the required ductility by plastic deformation of the threads within the nut.

Bolts supplied to AS/NZS 1252:1996 and now AS/NZS 1252.1:2016 are designed to fail in a manner similar to System HR and therefore EN 14399-3 System HR (not HV) bolts have been specified as the only alternative assembly type. The new Appendix A in AS/NZS 1252.1 provides further discussion on the performance differences between HR and HV systems within the context of Australian Standards and design practice.

Supply of bolt assemblies:

Irrespective of the similarity in geometry, mechanical properties and structural performance between the AS/NZS 1252.1 property class 8.8 bolt assemblies and the EN 14399-3 System HR property class 8.8 bolt assemblies, each assembly type is designed to act as a functional unit, particularly in respect of tightening performance. Therefore, bolts, nuts and washers from the two systems must not be used interchangeably in one bolt assembly. It is also strongly recommended that different bolt assembly types are not used in the same connection, and preferably not on the same structure. These latter requirements will help ensure on-site product traceability and minimise the potential for different components in the same bolt assembly.

Appendix D of this document provides a summary of the appropriate structural characteristics and performance attributes of property class 8.8 bolts to both AS/NZS 1252 and EN 14399-3 System HR, assessed using the design requirements of AS 4100.

AS/NZS 1252.1 – Additional assembly type

AS/NZS 1252:1996 defined only one strength grade of bolt assembly, being property class 8.8. Currently there is limited use of higher grade 10.9 bolt assemblies in both the Australian and New Zealand markets. Apart from a potential increase in the structural capacity of connections made with 10.9 bolts rather than 8.8 bolts, certain informed procurers have utilised 10.9 bolt assemblies due to the improved quality of supply that currently exists in the Australian marketplace, providing greater surety of compliance outcomes.

Committee ME-029 made the decision to incorporate EN 14399-3 System HR property class 10.9 bolt assemblies as an 'additional assembly type' in AS/NZS 1252.1. They may be utilised where reference is made to property class 10.9 fasteners conforming to AS/NZS 1252.1.

The structural properties of 10.9 bolt assemblies for use in connection design to AS 4100 need to be assessed based on the characteristics of the assembly components (shear and tensile areas etc.) and the appropriate design factors given in AS 4100. Note that at the time of writing, AS 4100 does not specifically include property class 10.9 bolt assemblies, although alternative solutions are not precluded by either AS 4100 or the National Construction Code (NCC) (Ref 13).

Appendix E of this document provides a summary of appropriate structural characteristics and performance attributes of property class 10.9 bolts to EN 14399-3 System HR, assessed using the design requirements of AS 4100.

New AS/NZS 1252.2 Verification testing for bolt assemblies

Arguably the most significant change to AS/NZS 1252 has been the creation of a new Part 2, titled 'Verification testing for bolt assemblies'. This represents a restricted form of third-party conformity assessment, to provide confidence in the product's conformity with AS/NZS 1252.1. Australian Standards drafting rules do not allow product conformity (as defined by the provisions in AS/NZS 1252.1) to be in the same document as conformity assessment, hence requiring the new Part 2.

Recognising the difficulty that stakeholders have been experiencing with properly assessing product conformity (of any construction product, not just high strength bolts), the ME-029 Standards committee decided that a Part 2 document was required, defining a formalised testing regime that is intended to be undertaken before the product is first put on the market in Australia. It is expected that in most cases the testing regime would be managed by the bolt importers, utilising either their own accredited labs or accredited third-party testing facilities.

AS/NZS 1252.2 provides definition of:

- Processes for selection of the correct type and range of samples to be tested
- The specific testing required for each of the critical product characteristics
- The credentials of testing laboratories utilised
- Review of the outcomes of the testing regime
- The form and extent of reporting
- The attestation of conformity, in the form of a Supplier Declaration of Conformity (SDoC)

It is important to note that Part 2 is not called up or mentioned in Part 1, but rather must be separately and optionally called up by the procurer/specifier to ensure that bolt assemblies are verified. **It is ASI's strong recommendation that all engineers/specifiers/procurers should call up high strength bolt assemblies to AS/NZS 1252.1, with verification testing to AS/NZS 1252.2.** The new ASI National Structural Steelwork Specification (Ref. 14) and 'Standard Drawing Notes' (Ref. 15) provides suitable wording.

PRODUCT PACKAGING AND IDENTIFICATION OF BOLT ASSEMBLIES

AS/NZS 1252.1 requires that:

- bolt assemblies are supplied to the purchaser either in the original unopened single sealed container or alternatively in the separate sealed containers of the manufacturer of the assemblies.
- The nuts, bolts and washers are supplied as a complete assembly from the one manufacturer.
- Mixing of different bolt assembly types in the same box is not permitted.

The delivery condition of high strength bolts is critical to the intended performance characteristics, in particular with regard to tensioning. Clean, dry unbroken packaging helps to ensure the intended surface condition is maintained. Similarly, storage and treatment on site must ensure the as-received condition of the assemblies is maintained.

Each package or box shall be clearly identified with the product designation, the name and address of the manufacturer or supplier, batch and heat identification number from which the bolt, nut and washer were taken, the k-class (where not shown, K0 shall be assumed) and a manufacturing or trace lot number.

TRACEABILITY OF BOLT ASSEMBLIES

A lot number is an alphanumeric code assigned by the manufacturer/distributor which identifies the manufacturer and the manufacturing lot number. Each diameter × length combination should have a separate lot number for traceability purposes.

It is essential that bolt importers/distributors, fabricators and erectors ensure traceability of the bolts used in a particular project by way of identifying each bolt diameter × length combination using the lot number on the box in which the bolts are supplied. The location where each lot number of bolts is used on the steel frame should also be recorded because once the bolts are removed from the box, they are no longer traceable unless a record is kept of what bolt diameter × length combination went where.

AS 4100 PROVISIONS

High strength bolt procurement

AS 4100 references AS/NZS 1252:1996. It is expected the reference will be updated to AS/NZS 1252.1 as part of the planned revision of AS 4100.

Design capacity of high strength bolts

For the strength limit state of high strength bolts, AS 4100 defines expressions for:

Bolt in tension (Clause 9.3.2.2 of AS 4100):

$$N_{\mathrm{tf}}^{*} \leq \emptyset N_{\mathrm{tf}}$$

where:

$\emptyset$	=	0.8 (Table 3.4 of AS 4100)
N_{tf}^{*}	=	design tension force
N_{tf}	=	nominal tensile capacity of a bolt = $A_{\mathrm{s}} f_{\mathrm{uf}}$
A_{s}	=	tensile stress area of a bolt
f_{uf}	=	minimum tensile strength of a bolt

Bolt in shear (Clause 9.3.2.1 of AS 4100):

$$V_{\mathrm{f}}^{*} \leq \emptyset V_{\mathrm{f}}$$

where:

∅	=	0.8 (Table 3.4 of AS 4100)
V_f^*	=	design shear force
V_f	=	nominal shear capacity of a bolt = $0.62 f_{uf} k_r (n_n A_c + n_x A_0)$
k_r	=	reduction factor given in Table 9.3.2.1 of AS 4100 to account for the length of a bolted lapped connection. Typically, and for all other cases, $k_r = 1.0$
f_{uf}	=	minimum tensile strength of a bolt
n_n	=	number of shear planes with threads intercepting the shear plane
n_x	=	number of shear planes without threads intercepting the shear plane
A_c	=	minor diameter area of the bolt as defined in AS 1275
A_0	=	nominal plain shank area of the bolt

Appendix B contains calculated capacities for bolts in shear and tension based on the AS 4100 requirements.

Compliance

The 1990 and 1998 editions of AS 4100 'Steel structures' contained no provisions in respect of certificates of compliance for bolts, unlike the provisions for steel for which a specific provision was specified. The 2012 Amendment to the 1998 edition of AS 4100 contains very specific provisions as follows:

> 'Test certificates that state that the bolts, nuts and washers comply with all the provisions of the appropriate Standard listed in Clause 2.3.1 shall constitute sufficient evidence of compliance with the appropriate Standard. Such test reports shall be provided by the bolt manufacturer or bolt importer and shall be carried out by an independent laboratory accredited by signatories to the International Laboratory Accreditation Corporation (Mutual Recognition Arrangement) (ILAC(MRA)) or the Asia Pacific Laboratory Accreditation Cooperation (APLAC) on behalf of the manufacturer, importer or customer. In the event of a dispute as to the compliance of the bolt, nut or washer with any of the Standards listed in Clause 2.3.1, the reference testing shall be carried out by independent laboratories accredited by signatories to ILAC(MRA) or APLAC.'

AS/NZS 1252 is a Standard listed in Clause 2.3.1 of AS 4100.

At the time of writing of this document, AS 4100 is in the process of a 'maintenance update' to incorporate changes resulting from revision or creation of a range of related Standards, including the new AS/NZS 5131 and the revised AS/NZS 1252:2016.

AS/NZS 5131 PROVISIONS

The new AS/NZS 5131 'Structural steelwork – Fabrication and erection' has incorporated the existing sections on fabrication and erection from AS 4100, introduced requirements from review of international good practice as well as a new risk-based fit-for-purpose classification of 'Construction Categories'. For a detailed analysis of AS/NZS 5131, refer to ASI Tech Note TN-011 (Ref. 16).

In respect of high strength bolts, AS/NZS 5131 includes:

(a) Definition of the applicable Standard for procurement of high strength bolts – AS/NZS 1252.1:2016

(b) Snug tightening of bolts

(c) Preparation of contact surfaces on connected plies

(d) Tensioning of high strength bolts

The provisions for snug tightening, preparation of contact surfaces and tensioning of high strength bolts in AS/NZS 5131 are essentially the same as in AS 4100:2012. It is expected that these provisions will be removed from AS 4100 as part of the next revision.

INFORMATION THAT SHOULD BE SUPPLIED – AS/NZS 1252.1

Where bolts have been supplied to AS/NZS 1252.1 (but not verified to AS/NZS 1252.2), the following information should be expected:

BOLT MANUFACTURER

The bolt manufacturer should be able to supply one or both of the following documents:

(a) Product certification from an internationally recognised third-party accreditation scheme including details of audits conducted. All information required under AS/NZS 1252:2016, AS 4291.1:2015 (Ref. 17) and AS/NZS 4291.2:2016 (Ref. 18) should be provided for each lot, the type and number of tests for each lot being in accordance with Section 6 and Appendix B of AS/NZS 1252.1:2016. The Certifier should be accredited to the ISO/IEC Guide 28 standard (Ref. 19) and any auditor should meet the requirements of ISO/IEC Guide 65 (Ref. 20). The certification scheme should meet the criteria in ISO/IEC Guide 28 which require the manufacturer to maintain effective planning to control the quality of production as well as testing from samples of production and verification of conformance.

(b) Results from a sampling and testing plan for each lot that complies with Section 6 and Appendix B of AS/NZS 1252.1:2016. All information required under AS/NZS 1252.1:2016, AS 4291.1:2015 and AS/NZS 4291.2:2016 should be provided for each lot. The test laboratory should be accredited to ILAC and any auditor should meet the requirements of ISO/IEC Guide 65.

Note that a lot for this purpose is defined as a bolt diameter and length from a particular heat of steel from a process with factory production control (FPC). Each lot should be identified for traceability according to the requirements of AS/NZS 1252.1.

BOLT IMPORTER/DISTRIBUTOR

The bolt importer/distributor should be able to supply the above information from the bolt manufacturer if requested. A Supplier Declaration of Conformity (SDoC) letter stating compliance with AS/NZS 1252.1:2016, AS 4291.1:2015 and AS/NZS 4291.2:2016 should be provided for each lot. The recommended contents of an SDoC is to be provided by the bolt importer/distributor is given in Appendix H.

If the bolt importer/distributor cannot supply the above information from the bolt manufacturer, then the importer/distributor is obliged to undertake a sampling and testing programme using an ILAC accredited laboratory and supply the results from a sampling and testing plan for each lot. All information required under AS/NZS 1252.1:2016, AS 4291.1:2015 and AS/NZS 4291.2:2016 should be provided for each lot. The test laboratory should be accredited to ILAC and any auditor should meet the requirements of ISO/IEC Guide 65. The importer/distributor should also provide the SDoC referencing the tests undertaken, as described in Appendix H.

Alternatively, the bolt importer/distributor can elect to carry out acceptance inspection in terms of AS/NZS ISO 3269 'Fasteners—Acceptance inspection' (Ref. 21), which is intended to guide the purchaser as to whether, considering the limitations of inspection by attributes of a fastener lot, it is reasonable to assume that the delivered fasteners were manufactured to the nominated specification.

CUSTOMER/FABRICATOR/ERECTOR

The Customer/Fabricator/Erector should insist that the above documentation for each lot be supplied when the bolts themselves are supplied. This should form a part of their Quality Assurance programme. Either the customer or fabricator or erector can engage a laboratory to undertake independent testing if so desired to verify the information supplied or to obtain any information that is missing. The test laboratory should be accredited to ILAC and any auditor should meet the requirements of ISO/IEC Guide 65.

AS/NZS ISO 3269 provides an acceptance inspection procedure that the purchaser of fasteners must follow in order to determine whether a lot should be accepted or rejected, as noted above.

Table 1 indicates the minimum level of information that should be in the possession of customer/fabricator/erector.

TABLE 1

Item
Identification and address of the supplier
Identification and address of the test laboratory and accreditation details of the test laboratory, details of laboratory accreditation
Date of issue, page number on each page
Test certificate number
Batch and heat identification number for each lot
Product identification for each lot
Customer purchase order number and heat number for each lot
Any other system reference numbers. These make sure that the product is fully traceable from the customer purchase order to the original steel used for its production.
Test, test specification, measured values in comparison to specification of all properties listed in the Appendix to this Technical Note for each lot
Statement of full compliance referring to Australian Standard AS/NZS 1252:2016 for each lot
Signature of authorised officer/position/name/date/accreditation
Any further information or tests that may be requested or as agreed with the supplier but may incur extra cost.

NOTE: All information should be in alphanumeric English. A ‘lot’ for the purpose of this Table is defined as a bolt diameter and length from a particular heat of steel.

INFORMATION THAT SHOULD BE SUPPLIED – AS/NZS 1252.2

Where bolts have been supplied to AS/NZS 1252.1 and verified to AS/NZS 1252.2, the amount of information required and extent of testing necessary is dramatically simplified. The following information should be expected:

BOLT MANUFACTURER

The type of information available from the bolt manufacturer is identical to that previously stated under AS/NZS 1252.1, and specifically results from a sampling and testing plan for each lot that complies with Section 6 and Appendix B of AS/NZS 1252.1:2016. All information required under AS/NZS 1252.1:2016, AS 4291.1:2015 and AS/NZS 4291.2:2016 should be provided for each lot. The test laboratory should be accredited to ILAC and any auditor should meet the requirements of ISO/IEC Guide 65.

Under the scenario where the bolt assemblies are intended to undergo verification testing to AS/NZS 1252.2, the need for separate product certification is diminished.

BOLT IMPORTER/DISTRIBUTOR

The bolt importer/distributor should be able to supply the above information from the bolt manufacturer if requested.

The bolt importer/distributor who first puts the product onto the market in Australia will manage verification testing of each assembly lot to the requirements of AS/NZS 1252.2 and must be able to provide:

- A Supplier Declaration of Conformity (SDoC) as required by AS/NZS 1252.2. The bolt importer need not reveal the identity of the manufacturer but shall assume full responsibility for the quality of the supplied bolts through issuing the SDoC. The recommended form of SDoC is given in Appendix H.

- If requested, copies of the test reports undertaken as part of the verification testing program

CUSTOMER/FABRICATOR/ERECTOR

The Customer/Fabricator/Erector should insist on receiving the SDoC from the importer/distributor for each lot of bolts procured, and check the manufacturing or trace lot number (as shown on the boxes or packages of bolts received) match the details provided in the SDoC.

The customer/fabricator/erector may choose to request copies of the test reports undertaken as part of the verification testing program if needed.

RECOMMENDED TESTING REGIME - WHERE AS/NZS 1252.2 IS NOT IMPLEMENTED

The market will take time to put in place the infrastructure and processes necessary to ensure widespread and cost-effective implementation of the requirements of AS/NZS 1252.2. It is expected that in this interim period there may be problems with procuring bolt assemblies that have had the verification testing requirements of AS/NZS 1252.2 undertaken.

Therefore, in this interim period, it is recommended that the testing regime outlined in Appendix I is added as an option in lieu of conformance to AS/NZS 1252.2 in procurement contracts and design specifications. An SDoC should also be supplied by the bolt importer/distributor.

SELECTION OF TESTING LABORATORIES

A Supplier Declaration of Conformity (SDoC) to AS/NZS 1252.2 involves verifying key manufacturing controls including material management, product identification, initial type testing and factory production controls then subsequent verification testing of product as-supplied (involving dimensional and mechanical testing of the components, as well as functional testing of the bolt assembly). The verification testing is performed in accordance with the test methods (and tolerances/thresholds) detailed in AS/NZS 1252.1. A further requirement is that the verification testing is required to be undertaken in a laboratory accredited by a signatory to the International Laboratory Accreditation Cooperation (ILAC) Mutual Recognition Agreement (MRA).

Note: Within Australia and New Zealand, this generally means either a NATA accredited laboratory (Australia) or IANZ accredited laboratory (New Zealand).

When engaging a laboratory to undertake the testing it is important that the supplier first establish that the selected laboratory holds accreditation for all of the nominated tests within AS/NZS 1252.1. Such detail regarding laboratory capability can be ascertained from the scope of accreditation (publicly available) which is issued to the laboratory by the accreditation body. The supplier should be aware that there are two different types of assembly test described within AS/NZS 1252.1. It is important to ensure that the laboratory holds accreditation for the particular type of test applicable for the class of bolts to be tested, namely the ‘basic’ (i.e. minimum nut rotation) assembly test which is required for Class K0 bolts or the ‘extended’ (i.e. torque-tension relationship) assembly test which is required for Class K1 or Class K2 bolts.

When submitting bolt assemblies for verification testing, the supplier will need to nominate the range of dimensional and physical tests required in accordance with AS/NZS 1252.1 (this may be achieved by reference to Tables 2.1 and 2.2 of AS/NZS 1252.2), including which of the assembly test options is required. Finally, to ensure compliance with AS/NZS 1252.2, a supplier seeking verification testing of their product should also nominate that the laboratory apply the re-testing and assembly lot rejection criteria as detailed in AS/NZS 1252.2 Clause 2.3.3.5 and 2.3.3.6.

CE MARKING OF BOLT ASSEMBLIES

Under the Construction Products Regulation (CPR), operable throughout member countries of the European Union, construction products under scope of a Harmonised European Standard (hEN) must be CE Marked. Marketing a product covered by an hEN in member countries of the EU without a valid CE mark is a criminal offence.

A CE Mark is placed on a product after a Notified Body (NB) has assessed the manufacturers design and fabrication process and certified the manufacturer to be acceptable. The context for that assessment is defined in the ZA Appendix of the hEN covering that product.

It is important to realise that the validity of CE marking only exists within the context of the CPR. There is no regulatory imperative in Australia to conform to CE Marking. Unscrupulous suppliers may claim CE Marking of product and supply questionable documentation. **Therefore, any claims of CE Marking for products (including bolts) imported into Australia may amount only to first party claims. In general, all high strength bolts, regardless of whether claimed to be CE Marked, should be verified to AS/NZS 1252.2.**

However, it is not in the best interests of the Australian community for properly verified CE Marked high strength bolts to incur the additional expense of verification testing to Part 2 of AS/NZS 1252 if the veracity of the CE Marking can be properly ascertained. If the procurer wishes to accept CE marked bolts in lieu of verification testing to Part 2 of AS/NZS 1252, then it is recommended the following auditing process is undertaken:

Step 1	
Obtain:	A copy of the Declaration of Performance (DoP)
Verify:	DoP includes: • Bolt type for which the DoP is applicable • Manufacturer details • Relevant harmonised EN Standard applicable • Details of the 'Notified Body(ies)' utilised for assessment under the Standard • Itemised range of tests (the 'essential characteristics') undertaken with specific reference to applicable clause in Standard
Step 2	
Obtain:	A copy of the Factory Production Control (FPC) certification
Verify:	FPC includes: • Name of the notified body undertaking the certification • Range of bolt assembly types covered under the certification • Name of the company certified • FPC certification is third party accredited
Step 3	
Compare:	DoP and FPC
Check:	• Name of the manufacturer and Notified Body are the same on each • Both documents include type of bolts (EN 14399 system HR property class 8.8 or 10.9 as appropriate) • Name of the company certified

The DoP and FPC are complementary documents that attest conformity to requirements of the relevant Standards and provides evidence of this conformity for a particular manufacturer. However, they are not specific to a particular batch of purchased bolt assemblies from that manufacturer. With respect to the particular batch of bolts purchased, Steps 4 and 5 are necessary.

Step 4	
Obtain:	Inspection or test certificates for the bolt batch purchased
Verify:	The inspection certificates include: • A listing of the tests undertaken and results • A batch or lot identification number for the assemblies tested • The name of the manufacturer • The certificate number of the CE marking applicable • Name and accreditation details of the laboratory used for testing Note: It is common for test certificates issued to conform to EN 10204 type 3.1
Check:	• The lot or batch identification number is consistent with that indicated on the packaging for the bolts purchased • All tests are passed • The name of the manufacturer is consistent with the DoP/FPC • The CE Marking certification is consistent with that indicated on the FPC certification • The laboratory used for testing is suitably accredited
Step 5	
Obtain:	Proof of testing laboratory accreditation
Check:	• The accreditation credentials of the testing lab Note: The accreditation credentials of the testing lab can usually be checked from the website of the testing lab or from that of the organisation that has provided the accreditation.

Quality suppliers of high strength bolts would usually have this information readily available for download off their website based on the manufacturer identification number for the batch of bolts purchased. Examples of typical documentation referenced above are included in Appendix F.

It is recommended as a matter of course that procurers do background checks on the veracity of the documentation. For quality supply, this is usually a quick website check of the certifying authority records. Certainly, if the above documentation is not readily available or the veracity of the documentation is in question, then a search of the certifiers website should be conducted to validate claims of conformance. Because the test protocols for EN14399 K1 and K2 are relatively more extensive and stringent than K0, procurers may wish to have verification testing to AS/NZS 1252.2 for their EN14399 K0 bolt assemblies in addition to checking the veracity of the documentation supplied.

With respect to checking the veracity of the Notified Body on any documentation, the website http://ec.europa.eu/growth/tools-databases/nando/index.cfm provides a list of notified bodies. Using as an example the documentation in Appendix F, the Notified Body number given on the DoP and FPC is 1020. From the 'Body' section of the website, for 1020 the page is http://ec.europa.eu/growth/tools-databases/nando/index.cfm?fuseaction=notifiedbody.notifiedbodies&num=1001&text=1001-1100 with the name for NB 1020 consistent with that shown on the certification documentation in Appendix F. Looking at the scope of their accreditation under the CPR, they are an FPC certification body for AVCP System 2+ for both the 2005 and 2015 versions of EN 14399-1.

The system of Assessment and Verification of Constancy of Performance (AVCP) defines the degree of involvement of third party notified bodies in assessing the conformity of a product. There are five systems of AVCP, the highest being 1+ (corresponding to safety-critical products) and the lowest being System Type 4. The tasks and responsibilities for each system are shown in Table G1 in Appendix G. Structural steel products are normally System Type 2+ of AVCP.

In the event that documentation cannot be validated, the purchaser should request verification testing to AS/NZS 1252.2 or reject the batch of bolts.

Given that CE Marking is not regulated in Australia, to maintain consistency in intent with the requirement for a Supplier Declaration of Conformity (SDoC) under AS/NZS 1252.2, and the regulated SDoC under the CPR, it is recommended that the procurer requests an SDoC from the Australian fastener supplier, which is appended to the CE Marking documentation, thereby ensuring the fastener supplier assumes legal responsibility for the declared performance of CE Marked product.

RESPONSIBILITY OF BOLT IMPORTERS/DISTRIBUTORS

Bolt importers/distributors need to be in a position to supply the information noted above from the bolt manufacturer and any testing that they have had done in Australia. It is the bolt importer's/distributor's responsibility to maintain traceability of information for every bolt supplied otherwise the issue of deceptive and misleading conduct arises under the Trade Practices Act. All necessary information noted above should be forwarded to the fabricator along with all other paperwork in connection with the bolts to be used on a particular project. In particular, a properly documented SDoC should be provided.

RESPONSIBILITY OF PROCURERS

ASI is strongly encouraging procurers to specify verification testing to AS/NZS 1252.2 or, in lieu of being able to secure this, the batch testing regime outlined in Appendix I. This provides the market with a known uniform regime of testing to help ensure compliant supply in a cost-effective manner. When considering the 'total cost of ownership' of the completed structure, careful attention needs to be paid not only to the initial cost of the bolt assemblies, but also the cost of additional paperwork and employee time in properly checking bolt assembly compliance (as variously detailed above), the risk of non-compliance and WHS obligations for duty of care, and the potential longer term maintenance issues if bolt assemblies do not perform as required.

Specifying verification testing to AS/NZS 1252.2 will dramatically reduce the time needed to properly verify compliance, minimise risk and demonstrate duty of care.

RESPONSIBILITY OF FABRICATORS AND ERECTORS

Both fabricators and erectors need to ensure that all necessary documentation noted above is available for every lot of bolts to be used on a project and maintain a register showing where each lot is used on a particular project. This should form part of a normal Quality Assurance system and should be forwarded to the builder and structural engineer for their information. Note that the new AS/NZS 5131 defines a regime of process and documentation required for procurement and fabrication of steel structures, including components such as high strength bolts.

Both fabricators and erectors need to consider whether to organise their own testing, particularly if not satisfied with the level of documentation supplied by the bolt importer/distributor.

RESPONSIBILITY OF STRUCTURAL ENGINEERS AND BUILDERS

Structural engineers should ensure the project specification and drawings correctly specify the required high strength bolts and verification testing (with option for the batch testing regime given in Appendix I if verification testing to AS/NZS 1252.2 is not available). The ASI 'National Structural Steelwork Specification' and 'Standard Drawing Notes' provide suitable guidance in this regard.

Both structural engineers and builders should insist on properly traceable documentation from the fabricator and erector, as well as a quality assurance record of what bolts were used in each bolted connection on a project and should not accept the steelwork on a project until satisfied fully about the status of the bolts. Both may need to consider whether to undertake their own testing if not satisfied by the level of documentation provided to them.

CONCLUSION

There has been a demonstrable issue with the quality and compliance of structural bolt assemblies in Australia over the past years. The 2016 revision of AS/NZS 1252 has been specifically designed to facilitate improved compliance outcomes for high strength bolts for the Australian marketplace. Apart from the improved product compliance in AS/NZS 1252, the most notable inclusion is the addition of Part 2 'Verification testing for bolt assemblies' which provides procurers the choice to require bolt assemblies are supplied with a known and defined level of testing independent from the bolt manufacturer.

The verification of product compliance is not a trivial task and, done properly to meet duty of care obligations, can take considerable resources. Under these circumstances, verification testing to Part 2 of AS/NZS 1252, or the proper verification of CE Marked product, is an effective, cost efficient and pragmatic approach to ensuring compliant supply.

ACKNOWLEDGEMENT

We wish to acknowledge the support of Hobson Engineering, Bremick Fasteners and Allthread Industries in kindly providing various images used in this Tech Note.

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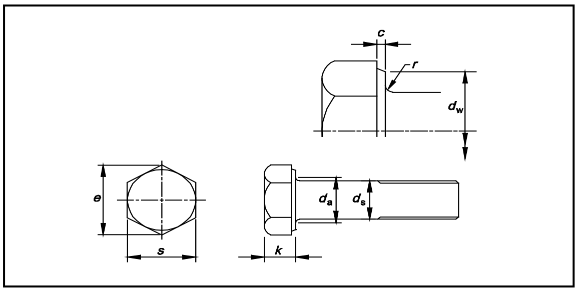
APPENDIX A

COMPARISON OF SIGNIFICANT BOLT DIMENSIONS

AS/NZS 1252 VERSUS EN 14399-3 TYPE HR



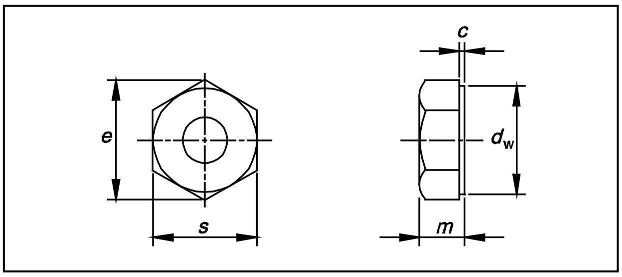
Bolt size	Dimension	AS/NZS 1252.1		EN 14399-3 TYPE HR	
		Max (mm)	Min (mm)	Max (mm)	Min (mm)
M12	Shank dia. (d_s)	12.70	11.30	12.70	11.30
	Width across flats (*s*)	21.0	20.16	22	21.16
	Width across corners (*e*)	24.25	22.78	-	23.91
	Washer face dia. (d_w)	Actual size across flats	19.2	Actual size across flats	20.1
	Depth of washer face (*c*)	0.8	0.4	0.8	0.4
	Fillet transition dia. (d_a)	14.7	-	15.2	-
	Fillet radius (*r*)	-	0.6	-	1.2
	Height of head (*k*)	7.95	7.05	7.95	7.05
M16	Shank dia. (d_s)	16.70	15.30	16.70	15.30
	Width across flats (*s*)	27	26.16	27	26.16
	Width across corners (*e*)	31.2	29.56	-	29.56
	Washer face dia. (d_w)	Actual size across flats	24.9	Actual size across flats	24.9
	Depth of washer face (*c*)	0.8	0.4	0.8	0.4
	Fillet transition dia. (d_a)	18.70	-	19.2	-
	Fillet radius (*r*)	-	0.6	-	1.2
	Height of head (*k*)	10.75	9.25	10.75	9.25
M20	Shank dia. (d_s)	20.84	19.16	20.84	19.16
	Width across flats (*s*)	32	31.00	32	31.00
	Width across corners (*e*)	36.9	35.03	-	35.03
	Washer face dia. (d_w)	Actual size across flats	29.5	Actual size across flats	29.5

	Depth of washer face (c)	0.8	0.4	0.8	0.4
	Fillet transition dia. (d_a)	23.24	-	24.4	-
	Fillet radius (r)	-	0.8	-	1.5
	Height of head (k)	13.90	12.10	13.40	11.60
M24	Shank dia. (d_s)	24.84	23.16	24.84	23.16
	Width across flats (s)	41	40.00	41	40.0
	Width across corners (e)	47.3	45.20	-	45.2
	Washer face dia. (d_w)	Actual size across flats	38.0	Actual size across flats	38.0
	Depth of washer face (c)	0.8	0.4	0.8	0.4
	Fillet transition dia. (d_a)	27.64	-	28.4	-
	Fillet radius (r)	-	1.0	-	1.5
	Height of head (k)	15.90	14.10	15.90	14.10
M30	Shank dia. (d_s)	30.84	29.16	30.84	29.16
	Width across flats (s)	50	49.00	50	49.0
	Width across corners (e)	57.7	55.37	-	55.37
	Washer face dia. (d_w)	Actual size across flats	46.5	Actual size across flats	46.6
	Depth of washer face (c)	0.8	0.4	0.8	0.4
	Fillet transition dia. (d_a)	34.24	-	35.4	-
	Fillet radius (r)	-	1.2	-	2.0
	Height of head (k)	19.75	17.65	19.75	17.65
M36	Shank dia. (d_s)	37.00	35.00	37.00	35.00
	Width across flats (s)	60	58.80	60	58.8
	Width across corners (e)	69.3	66.44	-	66.44
	Washer face dia. (d_w)	Actual size across flats	55.9	Actual size across flats	55.9
	Depth of washer face (c)	0.8	0.4	0.8	0.4
	Fillet transition dia. (d_a)	41.00	-	42.4	-
	Fillet radius (r)	-	1.5	-	2.0
	Height of head (k)	23.55	21.45	23.55	21.45

APPENDIX B

COMPARISON OF SIGNIFICANT NUT DIMENSIONS

AS/NZS 1252 VERSUS EN 14399-3 TYPE HR



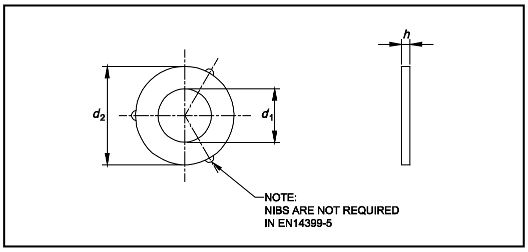
Nut size	Dimension	AS/NZS 1252.1		EN 14399-3 TYPE HR	
		Max (mm)	Min (mm)	Max (mm)	Min (mm)
M12	Width across flats (*s*)	21.0	20.16	22	21.16
	Width across corners (*e*)	24.25	22.78	-	23.91
	Nut height (*m*)	13.1	12.0	10.8	10.37
	Washer face or chamfer dia. (d_w)	Actual size across flats	19.20	Actual size across flats	20.1
	Depth of washer face (*c*)	0.8	0.4	0.8	0.4
	Countersink dia. (d_a)	13.00	12.00	13.0	12
M16	Width across flats (*s*)	27.0	26.16	27	26.16
	Width across corners (*e*)	31.2	29.56	-	29.56
	Nut height (*m*)	17.1	16.4	14.8	14.10
	Washer face or chamfer dia. (d_w)	Actual size across flats	24.90	Actual size across flats	24.90
	Depth of washer face (*c*)	0.8	0.4	0.8	0.4
	Countersink dia. (d_a)	17.30	16.00	17.3	16.0
M20	Width across flats (*s*)	32.0	31.00	32	31.00
	Width across corners (*e*)	36.9	35.03	-	35.03
	Nut height (*m*)	21.3	20.0	18.0	16.9
	Washer face or chamfer dia. (d_w)	Actual size across flats	29.50	Actual size across flats	29.50
	Depth of washer face (*c*)	0.8	0.4	0.8	0.4
	Countersink dia. (d_a)	21.60	20.00	21.6	20
M24	Width across flats (*s*)	41.0	40.00	41	40.00

	Width across corners (*e*)	47.3	45.20	-	45.20
	Nut height (*m*)	24.2	22.9	21.5	20.2
	Washer face or chamfer dia. (d_w)	Actual size across flats	38.00	Actual size across flats	38.00
	Depth of washer face (*c*)	0.8	0.4	0.8	0.4
	Countersink dia. (d_a)	25.90	24.00	25.9	24
M30	Width across flats (*s*)	50.0	49.00	50	49.00
	Width across corners (*e*)	57.7	55.37	-	55.37
	Nut height (*m*)	30.7	29.1	25.6	24.3
	Washer face or chamfer dia. (d_w)	Actual size across flats	46.50	Actual size across flats	46.60
	Depth of washer face (*c*)	0.8	0.4	0.8	0.4
	Countersink dia. (d_a)	32.40	30.00	32.4	30
M36	Width across flats (*s*)	60.0	58.80	60	58.80
	Width across corners (*e*)	69.3	66.44	-	66.44
	Nut height (*m*)	36.6	35.0	31.0	29.40
	Washer face or chamfer dia. (d_w)	Actual size across flats	55.90	Actual size across flats	55.90
	Depth of washer face (*c*)	0.8	0.4	0.8	0.4
	Countersink dia. (d_a)	38.90	36.00	38.9	36

APPENDIX C

COMPARISON OF SIGNIFICANT WASHER DIMENSIONS

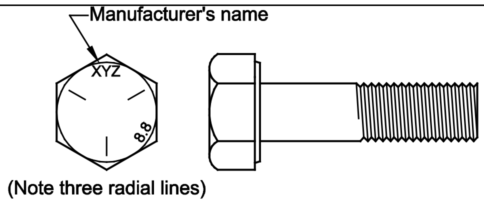
AS/NZS 1252 VERSUS EN 14399-5 TYPE HR



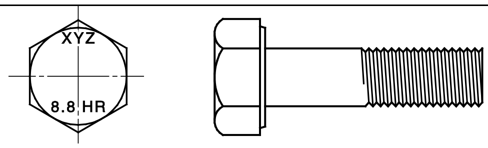
Washer size	Dimension	AS/NZS 1252.1		EN 14399-5 TYPE HR	
		Max (mm)	Min (mm)	Max (mm)	Min (mm)
M12	Inside diameter (d_1)	14.43	14.0	13.27	13
	Outside diameter (d_2)	27.0	25.7	24	23.48
	Thickness (h)	4.6	3.1	3.3	2.7
M16	Inside diameter (d_1)	18.43	18.0	17.27	17
	Outside diameter (d_2)	34.0	32.4	30	29.48
	Thickness (h)	4.6	3.1	4.3	3.7
M20	Inside diameter (d_1)	21.33	21.0	21.33	21
	Outside diameter (d_2)	39.0	37.4	37	36.38
	Thickness (h)	4.6	3.1	4.3	3.7
M24	Inside diameter (d_1)	26.52	26.0	25.33	25
	Outside diameter (d_2)	50.0	48.4	44	43.38
	Thickness (h)	4.6	3.4	4.3	3.7
M30	Inside diameter (d_1)	33.62	33.0	31.62	31
	Outside diameter (d_2)	60.0	58.1	56	54.80
	Thickness (h)	4.6	3.4	5.6	4.4
M36	Inside diameter (d_1)	39.62	39.0	37.62	37
	Outside diameter (d_2)	72.0	70.1	66	64.80
	Thickness (h)	4.6	3.4	6.6	5.4

APPENDIX D

STRUCTURAL PROPERTIES OF HIGH STRENGTH BOLT ASSEMBLIES TO AS/NZS 1252.1 OR EN 14399 SYSTEM HR



AS/NZS 1252.1 property class 8.8



EN 14399 System HR property class 8.8

STANDARD SPECIFICATION:	AS/NZS 1252.1 (Ref. 1) or EN 14399-3 (Ref. 12)	
PROPERTY CLASS:	8.8	
NORMAL METHOD OF MANUFACTURE:	Hot or cold forging, hardened and tempered	
MECHANICAL PROPERTIES:	Tensile strength	800 MPa (nom.), 830 MPa (min.)
	Stress at perm. set	640 MPa (nom.), 660 MPa (min.)
	Stress under proof load	600 MPa
MOST COMMONLY USED SIZES:	(M12), (M16), M20, M24, (M30), (M36)	
	( ) indicates available but rarely used	

NOTES:

1. For AS/NZS 1252.1, mechanical properties based on AS/NZS 4291.1:2015, which is identical copy of ISO 898.1:2013.

2. For EN 14399-3, mechanical properties based on ISO 898.1:2013.

TABLE D.1

DESIGN AREAS OF BOLTS

Nom. dia. (mm) d_f	Designation	Dimensions (mm)		Areas (mm^2)		
		Minor diameter d_1	*Pitch* P	A_c core (1)	A_s tensile stress (2)	A_o shank (3)
12	M12	9.853	1.75	76.2	84.3	113
16	M16	13.546	2	144	157	201
20	M20	16.933	2.5	225	245	314
24	M24	20.319	3	324	353	452
30	M30	25.706	3.5	519	561	706
36	M36	31.093	4	759	817	1016

NOTES:

1. The core area is based on the minor diameter d_1 of the thread, as defined in AS 1721 and calculated using the basic minor diameter defined in AS 1275 and thread pitch.

2. The tensile stress area is given in Table 3.3 of AS 1275:1985, termed 'stress area', or may be calculated using Clause 1.7 of AS 1275:1985. The identical values are given in Table 4 of AS 4291:2015.

3. The shank area is based on the nominal diameter of the bolt.

These properties are utilised to derive the bolt design capacities listed in Table D.2.

TABLE D.2

STRENGTH LIMIT STATE
HIGH STRENGTH STRUCTURAL BOLTS
(f_{uf} = 830 MPa)

Designation	Axial tension	Single shear	
		Threads included in shear plane N	Threads excluded from shear plane X
	ϕN_{tf}	ϕV_{fn}	ϕV_{fx}
	kN	kN	kN
M12	56.0	31.4	46.5
M16	104	59.3	82.7
M20	163	92.6	129
M24	234	133	186
M30	373	214	291
M36	542	312	418
	ϕ = 0.8	ϕ = 0.8	
		8.8N/S	8.8X/S

NOTES:

1. Axial tension capacity is based on Clause 9.3.2.2 of AS 4100, utilising the tensile stress area A_s

2. Single shear capacity is based on Clause 9.3.2.1 of AS 4100, utilising the core area A_c when threads are included in the shear plane and the shank area A_0 when threads are excluded from the shear plane

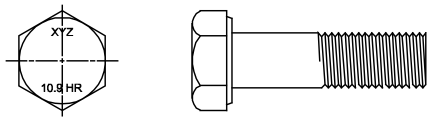
The characteristics, detailing and installation of bolts is discussed in Ref. 22.

Connection Handbook 1 (Ref.23) should be consulted for the theoretical background, design basis and design models for:

- Bolt group behaviour
- Bolt serviceability (slip)

APPENDIX E

STRUCTURAL PROPERTIES OF HIGH STRENGTH BOLT ASSEMBLIES TO EN 14399 SYSTEM HR PROPERTY CLASS 10.9



EN 14399 System HR property class 10.9

STANDARD SPECIFICATION:	EN 14399-3 (Ref. 12)		
PROPERTY CLASS:	10.9		
NORMAL METHOD OF MANUFACTURE:	Hot or cold forging, hardened and tempered		
MECHANICAL PROPERTIES:	Tensile strength	1000 MPa (nom.), 1040 MPa (min.)	
	Stress at perm. set	900 MPa (nom.), 940 MPa (min.)	
	Stress under proof load	830 MPa	
MOST COMMONLY USED SIZES:	(M12), (M16), M20, M24, (M30), (M36) ( ) indicates available but rarely used		

NOTES:

1. For EN 14399-3, mechanical properties based on ISO 898.1:2013.

TABLE E.1

DESIGN AREAS OF BOLTS

Nom. dia. (mm) d_f	Designation	Dimensions (mm)		Areas (mm^2)		
		Minor diameter d_1	*Pitch* P	A_c core [(1)]	A_s tensile stress [(2)]	A_o shank [(3)]
12	M12	9.853	1.75	76.2	84.3	113
16	M16	13.546	2	144	157	201
20	M20	16.933	2.5	225	245	314
24	M24	20.319	3	324	353	452
30	M30	25.706	3.5	519	561	706
36	M36	31.093	4	759	817	1016

NOTES:

1. The core area is based on the minor diameter d_1 of the thread, as defined in AS 1721 and calculated using the basic minor diameter defined in AS 1275 and thread pitch.

2. The tensile stress area is given in Table 3.3 of AS 1275:1985, termed ‘stress area’, or may be calculated using Clause 1.7 of AS 1275:1985. The identical values are given in Table 4 of AS 4291:2015.

3. The shank area is based on the nominal diameter of the bolt.

These properties are utilised to derive the bolt design capacities listed in Table E.2.

TABLE E.2

STRENGTH LIMIT STATE
HIGH STRENGTH STRUCTURAL BOLTS
(f_{uf} = 1040 MPa)

Designation	Axial tension(1)	Single shear(2)	
		Threads included in shear plane N	Threads excluded from shear plane X
	ϕN_{tf}	ϕV_{fn}	ϕV_{fx}
	kN	kN	kN
M12	70.1	0.833(4) x 39.3 = 32.7	58.3
M16	131	0.833(4) x 74.3 = 61.9	104
M20	204	0.833(4) x 116 = 96.6	162
M24	294	0.833(4) x 167 = 139	233
M30	467	0.833(4) x 268 = 223	364
M36	680	0.833(4) x 392 = 327	524
	ϕ = 0.8(3)	ϕ = 0.8(3)	
		10.9N/S	10.9X/S

NOTES:

1. Axial tension capacity is based on Clause 9.3.2.2 of AS 4100, utilising the tensile stress area A_s

2. Single shear capacity is based on Clause 9.3.2.1 of AS 4100, utilising the core area A_c when threads are included in the shear plane and the shank area A_0 when threads are excluded from the shear plane

3. ϕ = 0.8 has been selected as consistent with the current guidance in Table 3.4 of AS 4100 for bolts in shear, tension or combined shear and tension, which is consistent with the reciprocal of the γ_{M2} = 1.25 factor used in EN1993-1-8. However, note that AS 4100 does not currently specifically include property class 10.9 bolts and the choice of performance attributes for property class 10.9 bolt assemblies should be based on engineering judgement.

4. The single shear capacity of bolts in EN1993-1-8 is defined by the expression:

$$F_{v,Rd} = \alpha_v f_{ub} \frac{A_s}{\gamma_{M2}}$$

where:

A_s = tensile stress area of the bolt

f_{ub} = ultimate tensile strength of the bolt

γ_{M2} = 1.25

α_v = 0.6 when the shear plane passes through the unthreaded portion of the bolt

= as per the table below when the shear plane passes through the threaded portion of the bolt

Bolt class	4.6	4.8	5.6	5.8	6.8	8.8	10.9
α_v	0.6	0.5	0.6	0.5	0.5	0.6	0.5

For the case of threads included in the shear plane, to maintain consistency in the relative strength assessment between 8.8 and 10.9 bolts based on the differences in α_v, the strength values in Table E2 for threads included in the shear plane have an indicated reduction factor of 0.5/0.6 = 0.833 reducing the value calculated by applying the AS 4100 design expressions.

The reason for the reduced value of α_v = 0.5 for property class 10.9 bolts compared to 0.6 for property class 8.8 bolts when threads are included in the shear plane is due to the reduced ductility of 10.9 bolts and the increased stress (strain) concentration in the threaded portion, requiring more demand for ductility than in the unthreaded portion. The values of α_v are a result of a statistical analysis of test results to ensure that the partial factor of γ_{M2} = 1.25 was achieved.

APPENDIX F

EXAMPLE DOCUMENTATION ASSOCIATED WITH CE MARKING

F.1 Declaration of Performance (DoP)

[redacted] = Certain information is hidden for commercial reasons

DECLARATION OF PERFORMANCE
No. DoP-2016-05-001

1. Unique identification code of the product-type:
   EN14399-1 High-Strength structural bolting assemblies for preloading
   - Hexagon structural bolt, nut, 2 washers (EN 14399-3) : M12~M36 HR 8.8/8

2. Intended use/es:
   For structural connectors in structural metallic works

3. Manufacturer:
   [redacted]

Manufacturer

4. Authorised representative:
   N/A

5. System/s of AVCP
   System 2+

6a. Harmonised standard:
   EN 14399-1:2005

   Notified body/ies:
   Notified Body number : 1020
   TECHNICKY A ZKUSEBNI USTAV STAVEBNI
   Address: Prosecka 811/76a 190 00 PRAHA 9,

6b. European Assessment Document: N/A
   European Technical Assessment: N/A
   Technical Assessment Body: N/A
   Notified body/ies: N/A

7. Declared performance/s:

	Essential characteristics	Performance	Harmonised technical specification
Bolt	Percent elongation after fracture	ISO 898-1:2013 Table.3	EN 14399-1 : 2005
	Minimum Tensile Strength		
	Stress at 0,2 % non-proportional elongation		
	Stress under proof load		
	Stress under wedge loading		
	Hardness		
	Impact strength	EN 14399-3:2005 Table.3	
	Friction coefficient(k-class)	EN 14399-3:2005 Table.6	
	Release of dangerous substances	RoHS, REACH, CPR 305/2011/EU	
	Durability	NPD	
Nut	Stress under proof load	EN 14399-3:2005 Table.6	
	Hardness	ISO 898-2:2012 Table.6	
	Release of dangerous substances	RoHS, REACH, CPR 305/2011/EU	
	Durability	NPD	
Washer	Hardness	EN 14399-5:2005 Table.3	
	Release of dangerous substances	RoHS, REACH, CPR 305/2011/EU	
	Durability	NPD	
Set	Suitability for preloading	EN 14399-2:2005	
	Durability	NPD	

8. Appropriate Technical Documentation and/or Specific Technical Documentation:
   N/A

The performance of the product identified above is in conformity with the set of declared performance/s. This declaration of performance is issued, in accordance with Regulation (EU) No 305/2011, under the sole responsibility of the manufacturer identified above.

Signed for and on behalf of the manufacturer by:

[name] In Sueb , Cho
At [place] Chungju-City, Korea on[date of issue] 10th May. 2016

[signature] [redacted]

F.2 Factory Production Control (FPC) Certification

® TECHNICKÝ A ZKUŠEBNÍ ÚSTAV STAVEBNÍ PRAHA, s.p.
Technical and Test Institute for Construction Prague
Akreditovaná zkušební laboratoř, Autorizovaná osoba, Notifikovaná osoba, Oznámený subjekt, Subjekt pro technické posuzování, Certifikační orgán, Inspekční orgán / Accredited Testing Laboratory, Authorized Body, Notified Body, Technical Assessment Body, Certification Body, Inspection Body. Prosecká 811/76a, 190 00 Praha 9 - Prosek, Czech Republic

Notified Body 1020

CERTIFICATE OF CONFORMITY OF THE FACTORY PRODUCTION CONTROL

No. 1020 – CPR – 070038467

In compliance with Regulation 305/2011/EU of the European Parliament and of the Council of 9 March 2011 (the Construction Products Regulation or CPR), this certificate applies to the construction product:

High-strength structural bolting assemblies for preloading

System HV - Hexagon bolt and nut assemblies (Plain and H.D.G coating), dimensions M12, M16, M20, M22, M24, M27, M30, M36

System HRC - Bolt with cup head and hexagon nut assemblies with calibrated preload (Plain and Geomet coating), dimensions M12, M16, M20, M22, M24, M27, M30

System HR - Hexagon bolt and nut assemblies (Plain and H.D.G coating), dimensions M12, M16, M20, M22, M24, M27, M30, M36

produced by or for

and produced in the manufacturing plant

Manufacturer

This certificate attests that all provisions concerning the assessment and verification of constancy of performance described in Annex ZA of the standard

EN 14399-1:2005

under system 2+ for the performances set out in this certificate are applied and that

the factory production control fulfills all the prescribed requirements for these performances.

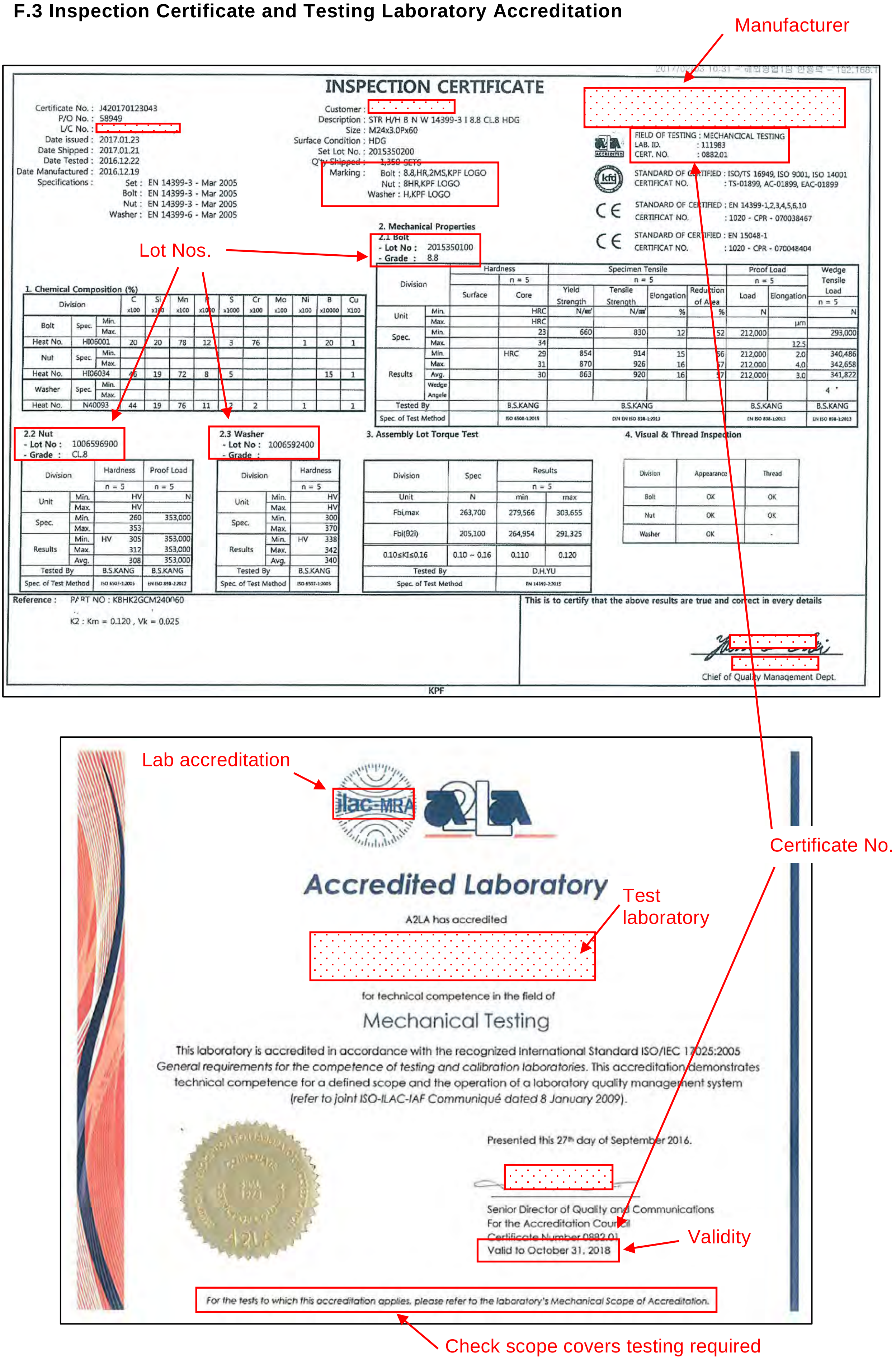
This certificate was first issued on 11 December 2009 under CPD and will remain valid as long as the test methods and/or factory production control requirements included in the harmonised standard, used to assess the performances of the declared essential characteristics, do not change, and the construction product, and the manufacturing conditions in the plant are not modified significantly, unless suspended or withdrawn by the factory production control certification body.

TECHNICKÝ A ZKUŠEBNÍ ÚSTAV STAVEBNÍ PRAHA, s.p. OZNÁMENÝ SUBJEKT 1020 ÚNMZ 07

The stamp of the Notified Body 1020
Ostrava, October 22, 2014

Dipl. Eng.
Deputy manager of the Notified Body

F.3 Inspection Certificate and Testing Laboratory Accreditation



INSPECTION CERTIFICATE

[redacted]

FIELD OF TESTING : MECHANCICAL TESTING
LAB. ID. : 111983
CERT. NO. : 0882.01

STANDARD OF CERTIFIED : ISO/TS 16949, ISO 9001, ISO 14001
CERTIFICAT NO. : TS-01899, AC-01899, EAC-01899

STANDARD OF CERTIFIED : EN 14399-1,2,3,4,5,6,10
CERTIFICAT NO. : 1020 - CPR - 070038467

STANDARD OF CERTIFIED : EN 15048-1
CERTIFICAT NO. : 1020 - CPR - 070048404

Certificate No. : J420170123043
P/O No. : 58949
L/C No. : [redacted]
Date issued : 2017.01.23
Date Shipped : 2017.01.21
Date Tested : 2016.12.22
Date Manufactured : 2016.12.19
Specifications : Set : EN 14399-3 - Mar 2005
Bolt : EN 14399-3 - Mar 2005
Nut : EN 14399-3 - Mar 2005
Washer : EN 14399-6 - Mar 2005

Customer : [redacted]
Description : STR H/H B N W 14399-3 I 8.8 CL.8 HDG
Size : M24x3.0Px60
Surface Condition : HDG
Set Lot No. : 2015350200
Q'ty Shipped : ~~1,350 SETS~~
Marking : Bolt : 8.8,HR,2MS,KPF LOGO
Nut : 8HR,KPF LOGO
Washer : H,KPF LOGO

1. Chemical Composition (%)

Division			C x100	Si x100	Mn x100	P x1000	S x1000	Cr x100	Mo x100	Ni x100	B x10000	Cu X100
Bolt	Spec.	Min.										
		Max.										
Heat No.	HI06001		20	20	78	12	3	76		1	20	1
Nut	Spec.	Min.										
		Max.										
Heat No.	HI06034		46	19	72	8	5				15	1
Washer	Spec.	Min.										
		Max.										
Heat No.	N40093		44	19	76	11	2	2		1		1

2. Mechanical Properties

2.1 Bolt
- Lot No : 2015350100
- Grade : 8.8

Division		Hardness Surface	Hardness Core (n = 5)	Specimen Tensile Yield Strength (n = 5)	Tensile Strength	Elongation	Reduction of Area	Proof Load Load (n = 5)	Proof Load Elongation	Wedge Tensile Load (n = 5)
Unit	Min.		HRC	N/㎟	N/㎟	%	%	N		N
	Max.		HRC						μm	
Spec.	Min.		23	660	830	12	52	212,000		293,000
	Max.		34						12.5	
Results	Min.		HRC 29	854	914	15	56	212,000	2.0	340,486
	Max.		31	870	926	16	57	212,000	4.0	342,658
	Avg.		30	863	920	16	57	212,000	3.0	341,822
	Wedge Angele									4 °
Tested By			B.S.KANG	B.S.KANG				B.S.KANG		B.S.KANG
Spec. of Test Method			ISO 6508-1:2015	DIN EN ISO 898-1:2013				EN ISO 898-1:2013		EN ISO 898-1:2013

2.2 Nut
- Lot No : 1006596900
- Grade : CL.8

Division		Hardness (n = 5)	Proof Load (n = 5)
Unit	Min.	HV	N
	Max.	HV	
Spec.	Min.	260	353,000
	Max.	353	
Results	Min.	HV 305	353,000
	Max.	312	353,000
	Avg.	308	353,000
Tested By		B.S.KANG	B.S.KANG
Spec. of Test Method		ISO 6507-1:2005	EN ISO 898-2:2012

2.3 Washer
- Lot No : 1006592400
- Grade :

Division		Hardness (n = 5)
Unit	Min.	HV
	Max.	HV
Spec.	Min.	300
	Max.	370
Results	Min.	HV 338
	Max.	342
	Avg.	340
Tested By		B.S.KANG
Spec. of Test Method		ISO 6507-1:2005

3. Assembly Lot Torque Test

Division	Spec	Results (n = 5) min	max
Unit	N	min	max
Fbi,max	263,700	279,566	303,655
Fbi(θ2i)	205,100	264,954	291,325
0.10≤KI≤0.16	0.10 ~ 0.16	0.110	0.120
Tested By		D.H.YU	
Spec. of Test Method		EN 14399-2:2015	

4. Visual & Thread Inspection

Division	Appearance	Thread
Bolt	OK	OK
Nut	OK	OK
Washer	OK	-

Reference : PART NO : KBHK2GCM240060
K2 : Km = 0.120 , Vk = 0.025

This is to certify that the above results are true and correct in every details

[redacted]

Chief of Quality Management Dept.

KPF

ilac-MRA A2LA

Accredited Laboratory

A2LA has accredited

[redacted]

for technical competence in the field of

Mechanical Testing

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005 *General requirements for the competence of testing and calibration laboratories.* This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (*refer to joint ISO-ILAC-IAF Communiqué dated 8 January 2009*).

Presented this 27th day of September 2016.

[redacted]

Senior Director of Quality and Communications
For the Accreditation Council
Certificate Number 0882.01
Valid to October 31, 2018

For the tests to which this accreditation applies, please refer to the laboratory's Mechanical Scope of Accreditation.

APPENDIX G

SYSTEM OF ASSESSMENT AND VERIFICATION OF CONSTANCY OF PERFORMANCE (AVCP)

The assessment of conformity tasks according to the Construction Products Regulation under AVCP is indicated in Table G1

TABLE G1

		System type				
		1+	1	2+	3	4
Tasks for the notified body	Assessment of products performance based on testing, calculation, tabulated values or descriptive documentation	X	X			
	Initial inspection of the manufacturing plant	X	X	X	X	
	Initial inspection of the FPC system	X	X	X	X	
	Continuing surveillance of the FPC system	X	X	X	X	
	Audit testing	X				
	To issue, restrict, suspend or withdraw a certificate of constancy of performance	X	X	X	X	
Tasks for the manufacturer	Assessment of products performance based on testing, calculation, tabulated values or descriptive documentation			X		X
	FPC and further testing of samples	X	X	X		
	FPC				X	X
	Determination of the product-type	X	X	X	X	X

APPENDIX H

CONTENT AND STRUCTURE OF SUPPLIER DECLARATION OF CONFORMITY (SDoC)

H.1 Context

AS/NZS 1252.2 requires attestation of compliance to take the form of a Supplier's Declaration of Conformity (SDoC) applicable to the batch(es) or product type(s) for which product conformity is required to be established. Whilst this is a requirement for any product supplied in compliance with AS/NZS 1252.2, ASI strongly recommends that an SDoC is also required by procurers either where compliance to AS/NZS 1252.2 has not been specified or where it has been specified and the market is not able to supply product with evidence of compliance to AS/NZS 1252.2. In this latter case, the range of required third party testing must be specified in the procurement specification and the SDoC must specifically refer to that testing regime. A minimum suggested batch testing regime recommended by ASI is provided in Clause H.2.

H.2 Minimum recommended batch testing regime

There may be circumstances where the procurer cannot obtain product that has been verified to AS/NZS 1252.2 but has demonstrable compliance to AS/NZS 1252.1 as described elsewhere in this Technical Note. In this case, the ASI recommends the minimum batch testing regime for each batch of bolts as specified in Appendix I.2. **Please note that the specified batch test regime is not applicable to bolts made to AS1252-1983 or AS/NZS1252-1996**, which should not now be accepted by procurers.

H.3 Content of a Supplier Declaration of Conformity

AS ISO/IEC 17050.1 'Conformity assessment – Supplier's declaration of conformity, Part 1: General requirements' is called up by AS/NZS 1252.2 and provides a minimum required contents for the SDoC, namely:

1. Unique identification of the SDoC;
2. The name and contact address of the issuer of the SDoC;
3. The identification of the object of the SDoC (e.g. name, type, date of production, model number and other relevant supplementary information);
4. The statement of conformity;
5. A complete and clear list of Standards or other specified requirements, including any options;
6. The date and place of issue of the SDoC;
7. The signature, name and position of the authorised person acting on behalf of the issuer of the SDoC;
8. Any limitation on the validity of the SDoC;
9. Any additional supporting information;

Examples of additional supporting information are indicated in AS ISO/IEC 17050.1.

ASI recommends the following additional supporting information is provided as part of the SDoC:

1. The name and address of the conformity assessment body involved (e.g. for the testing);
2. Reference to the accreditation documents of the conformity assessment bodies involved;
3. Reference to the relevant test reports;

H.4 Example Supplier Declaration of Conformity

Based on the above recommended scope of the SDoC, an example SDoC is provided overpage.

Declaration of Conformity

XYZ Company Pty Ltd

Certificate no.:	
Company name:	
Company ABN:	
Company address:	
Bolt compliance:	We declare the bolts described below under 'Bolt batch identification' have been supplied complying to all the requirements of AS/NZS1252.1:2016, including but not limited to: • Performance requirements of the bolt assembly according to Section 5; • Identification requirements on packaging according to Clause 6.3; • Testing and test reports according to Clause 6.4; • Testing of dimensional requirements, mechanical properties and functional characteristics according to Clauses 6.5, 6.6 and 6.7 respectively; • Product conformity according to Appendix B.
Scope of testing:	We declare independent third-party testing has been undertaken to: Option 1: AS/NZS 1252.2:2016 Option 2: Batch testing described in Attachment A to this SDoC The required documentation is available on request.
Testing authority and accreditation:	
Test certificates and reports:	
Bolt type:	AS/NZS 1252.1 (Option: EN14399 Type HR)
Bolt grade:	8.8 (Option: Grade 10.9)
Bolt batch identification:	

Additional information:

…………………………………………………………………………………………………….

…………………………………………………………………………………………………….

…………………………………………………………………………………………………….

Signed:	
Position:	
Date and place of issue:	

Declaration of Conformity

Attachment A – Scope of Batch Testing

Certificate no.:	
Company name:	
Company ABN:	
Company address:	
Scope of testing:	(a)
Testing authority and accreditation:	
Test certificates and reports:	
Bolt type:	AS/NZS 1252.1 (Option: EN14399 Type HR)
Bolt grade:	8.8 (Option: Grade 10.9)
Bolt batch identification:	

APPENDIX I
RECOMMENDED BATCH TESTING REGIME

I.1 Context

It is fair to say that, at the time of writing of this Technical Note revision, the implementation of the processes and equipment necessary to support the verification testing requirements of AS/NZS 1252.2 by the Australian market has been limited. The reasons for this are understood to include a view by some suppliers that the testing regime in AS/NZS 1252.2 is somewhat excessive and not fit-for-purpose in that the costs involved will not be acceptable to procurers and that there is a lack of commitment by testing laboratories to put in place the infrastructure with unknown or ill-defined demand.

The process of undertaking a revision to AS/NZS 1252.2 to address these issues is underway, but will take time. In the interim, ASI recommends that specifiers and procurers call up the testing regime outlined in this Appendix, which meets the performance intent of the expected revision to AS/NZS 1252.2 and is based on the paper “Verification of conformity – Structural fasteners to AS/NZS 1252:2016 – A discussion paper” by Professors Saman Fernando and Emad Gad of Swinburne University of Technology (available from ASI on request).

Compounding this issue, there are reports from large procurers of issues with bolt assembly supply, including:

- Bolt assemblies supplied with box markings indicating manufacture to AS/NZS 1252, with no date for the applicable Standard revision. Bolt assembly packaging must clearly state manufacture is to AS/NZS 1252.1:2016. The lack of distinction and date in this regard brings into question whether the supplied bolt assemblies are to the current Standard or the previous Standard. In this case, bolt procurers must question the supplier and have the choice to require bolt assemblies to AS/NZS 1252.1:2016.
- Bolt assemblies supplied with box markings indicating manufacture to AS/NZS 1252:1983 which is now outdated by two revisions!

Note that the use of product to clearly outdated versions of the Standard may infringe regulatory requirements, such as the National Construction Code.

These issues, amongst others, confuse the procurement market and lead to lack of confidence in bolt supply.

I.2 Bolt Assembly batch Testing Regime

The recommended bolt assembly testing regime is indicated in the flowchart in Figure I.1.

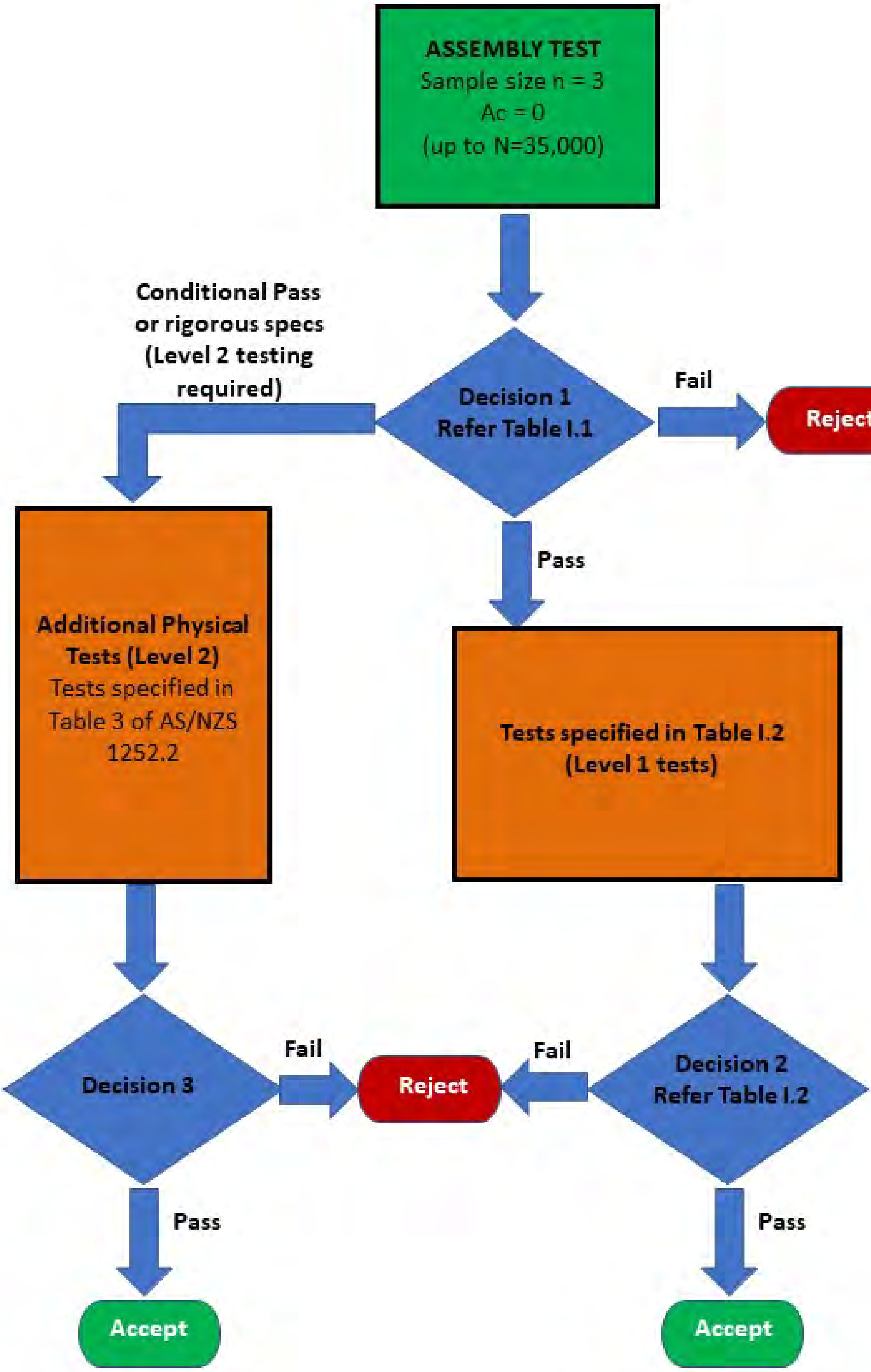


Figure I.1 Bolt Assembly Batch Testing Regime

Notes:

1. A sample size of n = 3 from a batch of bolts of up to total size N = 35,000 is recommended. Larger batch sizes would require additional test samples, but is considered not relevant to batch testing on the scale of a project.
2. This test regime is based on the assumption that the Assembly Test is a “Fit for Purpose” test.

3. The Assembly Test is the ‘Basic Assembly Test’ defined in AS/NZS 1252.1 Appendix D for bolt assemblies classified to k-class K0 (those not tightened using torque controlled methods, which is the usual case in Australia). When it is intended to use k-class K1 or K2 (for bolt assemblies to be tightened using torque control), the ‘Extended Assembly Test’ defined in AS/NZS 1252.1 Appendix D must be used.
4. The initial “Decision 1” covers observation of a range of physical parameters as noted in Table I.1.
5. Table I.2 testing is applied once the Assembly test is passed. These tests verify the parameters that are not tested by the Assembly test. ‘Other specified characteristics’ mean specific tests that the procurer may require and documented in the procurement specification (e.g. Charpy test for low temperature applications). In most cases, there will be no other specified characteristics to be tested. Decision 2 is based on the conformance to Table I.2. It is expected that all good quality product will go through this path.
6. When the observations given in Table I.1 indicate further uncertainties of the batch (Conditional pass, supplier pays) or where the procurer requires a more rigorous testing regime (procurer may need to cover the costs in this case), the testing specified in AS/NZS 1252.2 is undertaken. This Level of testing would usually only be required for special purpose structures or where the relevant authority requires it. Decision 3 is based on the conformance to AS/NZS 1252.2. These tests add additional costs to suppliers and may only be needed when the quality of the product is somewhat uncertain. Therefore, it will be beneficial to the suppliers to procure better quality product from better quality manufacturers.
7. The procurer should request an SDoC covering the testing regime undertaken.

I.3 Decision 1

This table should be read in conjunction with Figure I.1. After/during the assembly tests the following parameters should be visually inspected/observed before deciding on the pass, conditional pass or rejection.

Table I.1 Decision 1 Inspection Scope

Observation (Visual)	Concern	Decision
$F_{bi,max}$	Below specification AS1252.1	Reject the batch
$\Delta\theta_2$	Below Specification AS1252.1	Reject the batch
Thread stripping failure	Too large $\Delta\theta_2$, not acceptable under HR classification	Reject the batch
Wobbly assembly and set-up during test.	Symmetry Concentricity Squareness	Conditional pass.
Washer too tight or too loose.	Washer not suitable.	Conditional pass.

Washer excessively deformed and/or scored. $\Delta\theta_2$ is too large	Under head bearing surface not effective Under head fillet radius faulty	
Noticeable head damage or burring after test	Inadequate A/F or hardness of head	Conditional pass.
Noticeable nut damage or burring after test	Inadequate A/F or hardness of nut	Conditional pass.

If none of the above is observed then the Assembly test is passed. No further assembly tests are necessary and the right-hand side path, Table I.2 testing of Figure I.1, should be followed.

A conditional pass should follow the left-hand side of the path with testing to AS/NZS 1252.2 as shown in Figure I.1.

I.4 Decision 2

When the assembly test is unconditionally passed for all samples the following tests should be conducted.

Table I.2 Decision 2 Inspection Scope

Dimensional characteristic (see Note)	Sample Size (n)	Acceptance no. (Ac)	Rejection no. (Re)
If number of non-conformity is greater than or equal to Re reject the batch			
Bolts:			
Bolt length	3	0	1
Shank Length	3	0	1
Coating thickness	3	0	1
Any other specified characteristics			
Nuts:			
Coating Thickness	3	0	1
Any other specified characteristics			
Washers:			
Hole diameter (d_1)	3	0	1
Outside diameter (d_2)	3	0	1
Thickness/chamfer (h)	3	0	1
Coating thickness	3	0	1
Any other specified characteristics			

Mechanical characteristic			
Washers:			
Hardness	3	0	1
Any other specified characteristics			

NOTE: Symbols are defined in Figures 2.1, 3.1 and 4.1 of AS/NZS 1252.1 as appropriate.

Use of a calibrated Vernier Calliper is acceptable. ILAC accreditation on dimensional measurement is not required.
Mechanical characteristics tests shall be done by a third party ILAC accredited organisation.

Accept or reject the product based on the conformance to the above Table I.2.

I.5 Decision 3

When the assembly test is conditionally passed or the procurer specifies a rigorous testing regime the additional tests in accordance with AS/NZS 1252.2 should be undertaken.

Accept or reject the product based on the conformance to AS/NZS 1252.2.