Standing Committee on Concrete Technology
Annual Concrete Seminar 2013

Construction Standard CS2:2012 - Steel Reinforcing Bars for the Reinforcement of Concrete

Speakers:

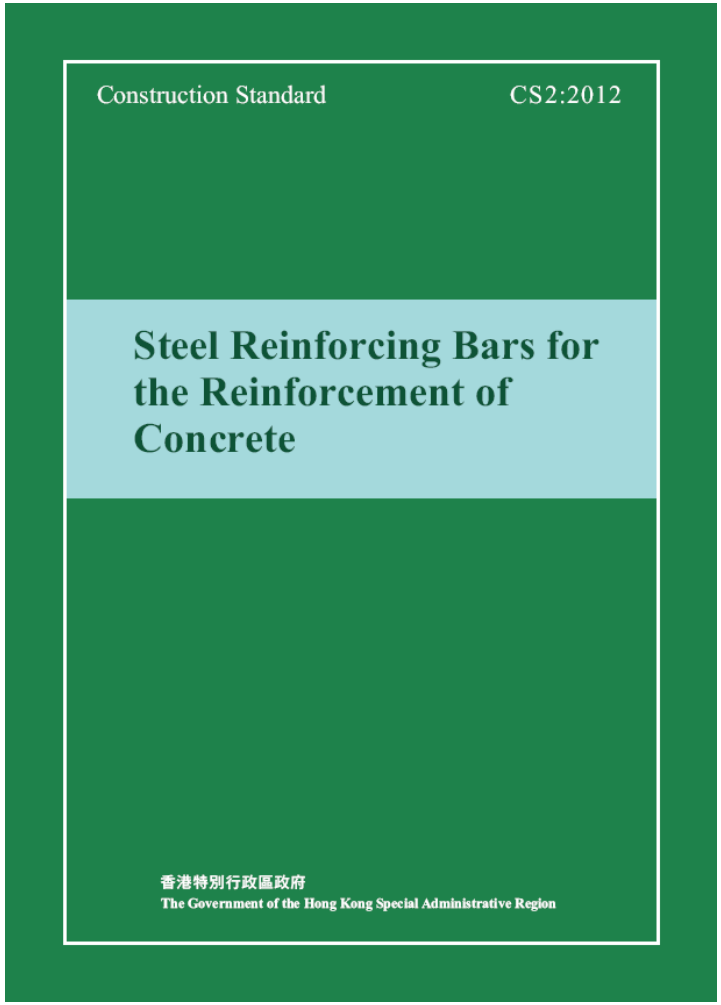
Ir Tony Cheung — Technical Secretary/Structural Buildings Department

Ir Francis Wong — Senior Structural Engineer/18 Housing Department

18 April 2013

CS2:2012

- Background
- Major Changes / New Features
- Commentaries
- Implications
- Purchaser Testing
- Implementation
- Other information



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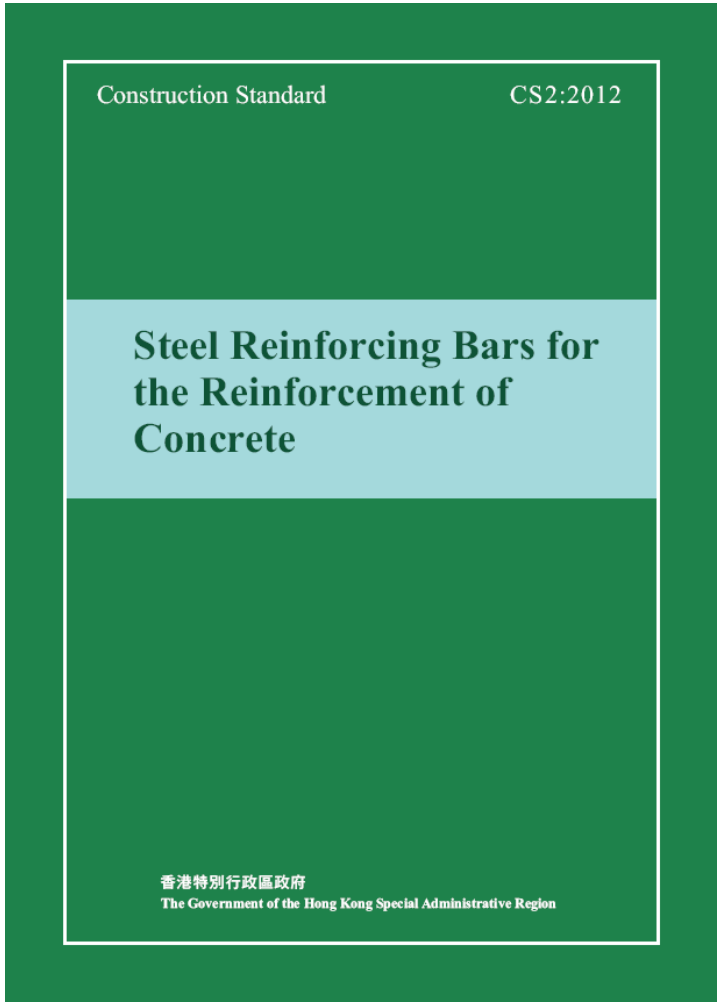

Background (1/2)

- The CS2 was prepared by the Working Group on Review of CS2 under the SCCT, Development Bureau
- Review of the CS2 comprises two stages
  - Stage 1 : Update the technical specification and quality assurance system for steel reinforcing bars (completed)
  - Stage 2 : Include the requirements for product certified steel reinforcing bars (yet to commence)
- Review of the CS2 started in 2008 with the Stage 1 review completed in 2012

Background (2/2)

- Major reference of CS2:1995
  - BS 4449:1988 for ribbed steel reinforcing bars and plain steel reinforcing bars
- Major reference of CS2:2012
  - BS 4449:2005+A2:2009 for ribbed steel reinforcing bars; and
  - BS 4482:2005 for plain steel reinforcing bars up to 12 mm diameter

Major Changes / New Features in CS2:2012

1. Increase in yield strength of ribbed steel reinforcing bars
2. Purchaser testing on chemical composition
3. Purchaser testing on bond properties
4. Purchaser testing on mass
5. Deletion of “Class 3” steel reinforcing bars
6. Handling of non-conforming steel reinforcing bars

1. Increase in yield strength of ribbed steel reinforcing bars

CS2:1995	CS2:2012
460 MPa	500 MPa (grade 500B and 500C) [clause 1.6.2 and other relevant clauses]

Commentary

1. Characteristic yield strength of 500 MPa has been allowed in the latest international structural design standards
   - Eurocode 2
   - BS8110:1997+A1:2007

2. Bring about more energy-efficient and cost-effective reinforced concrete structures

3. A review of about 6,000 nos. of test results of steel reinforcing bars used in private developments in Hong Kong in 2008 and 2009 revealed that 95% of the bars had yield strength greater than 500 MPa

2. Purchaser testing on chemical composition

CS2:1995	CS2:2012
No testing requirement although the required composition of some chemical elements is specified	➢ Testing on chemical composition required [5.1.2.2 and other relevant clauses] ➢ Requirement on chemical composition is revised for some elements (e.g. Carbon) and added for additional elements (e.g. Copper) [clause 1.5.1] ➢ New testing methods are specified [clause 6.3]

Commentary

1. Quality control of the chemical composition is a fundamental part in the steel manufacturing process:
   - The chemical composition of steel reinforcing bars governs a wide range of physical and mechanical properties of the material, including the durability of the bars for which no other compliance test is specified for quality control

2. The requirement for purchasers testing on chemical composition has not been previously included in CS2:1995 for steel reinforcing bars used in Hong Kong because suitable testing capability was not readily available locally at the time

3. Purchaser testing on bond properties

CS2:1995	CS2:2012
No testing requirement although bond classification is specified	➢ Testing on Bond Property required [5.1.2.2 and other relevant clauses] ➢ Requirement specified [clause 1.7] ➢ Testing Methods specified [clause 6.7]

Commentary

1. Anchorage bond stress is affected by the surface geometry of steel reinforcing bars
   - The correlation between the allowable bond stress and the surface geometry of the bars is specified in design standards, e.g. BS8110, EC2
   - Use of steel reinforcing bars with higher tensile strength calls for corresponding increase in bond capacity

2. The requirement on purchaser testing on bond property has not been previously included in CS2:1995 for steel reinforcing bars used in Hong Kong because suitable testing capability was not readily available locally at the time

4. Purchaser testing on mass

CS2:1995	CS2:2012
No testing requirement although the nominal cross-sectional area and mass per metre are specified	➢ Measurement on mass per metre is required ➢ The permissible deviation of the nominal mass per metre for different grades of steel is updated [clauses 1.4.1 and 1.4.2]

Commentary

With the utilization of higher material strength, the bar size is important to achieve the designed structural capacity of the bars. Quality control on the nominal diameter of the steel reinforcing bars, which are derived from the nominal mass per metre, is essential. Any reduction in mass will mean a lowering in the capacity (in terms of 'force') of the steel reinforcing bar.

5. Deletion of “Class 3” steel reinforcing bars

CS2:1995	CS2:2012
“Class 3” steel reinforcing bars are bars from a non-quality assured steel manufacturer and handled by a quality assured stockist	“Class 3” steel reinforcing bars are no longer allowed to be used

Commentary

1. This is to avoid the use of steel reinforcing bars from a non quality assured source

2. “Class 3” steel reinforcing bars” is rarely used nowadays in Hong Kong, deletion of Class 3 steel reinforcing bars will not adversely affect the supply of steel reinforcement bars for use in Hong Kong

6. Handling of non-conforming steel reinforcing bars

CS2:1995	CS2:2012
The BSI QA System for Registered Stockist has been withdrawn	➢ The QA stockists is required to certify to the requirements of ISO 9001 by a certification body accredited by HKAS [clause 4.1] ➢ New requirements for handling non-conforming steel reinforcing bars are stipulated as part of the certification requirements for QA stockists [clause 4.2]

Commentary

Proper handling of non-conforming steel reinforcing bars is an integral part of the quality management system for stocklists in order to guard against intentional/accidental re-use of sub-standard steel reinforcing bars

Thank you

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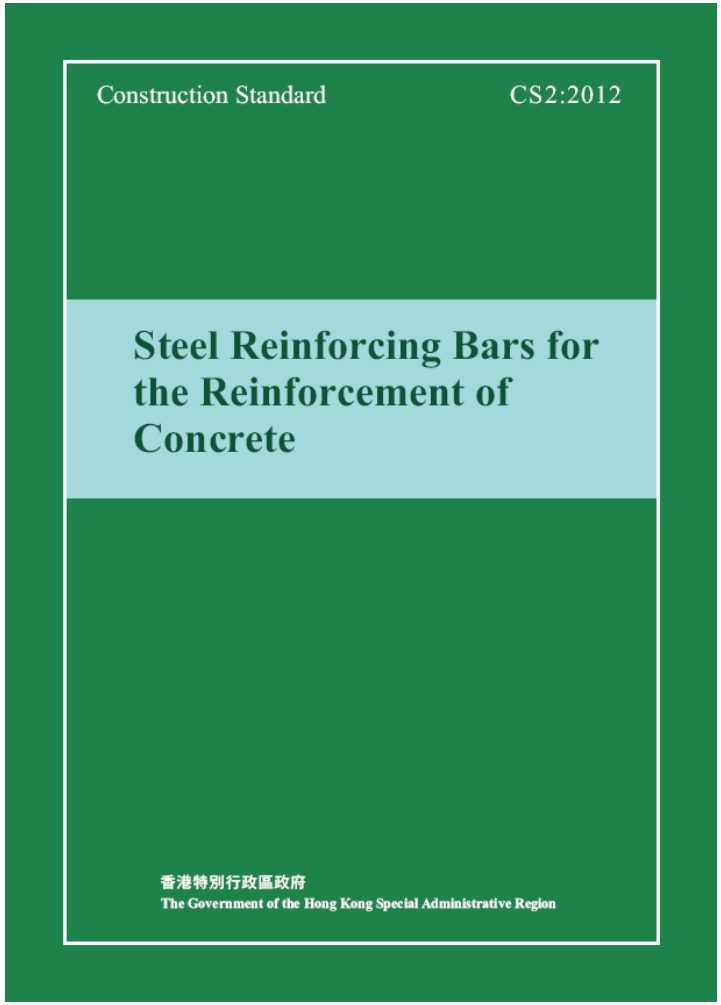


Implications (1/3)

- Yield strength
  - A more economic design by using less reinforcement
  - As consulted with Stockists, the change to 500 MPa steel should not cause supply problem
  - There are changes in the test method, laboratories have to acquire HOKLAS accreditation

- Purchaser testing on chemical composition
  - One test per diameter per batch [Table 10]
  - Laboratories will have to install spectrometers and acquire HOKLAS accreditation (spectrometer bought by PWCL last year at around HK$600,000)

Implications (2/3)

- Purchaser testing on bond property
  - One test per diameter per batch [Table 10]
  - Laboratories will have to install instrument in measuring the rib geometry of reinforcement bars and acquire HOKLAS accreditation (equipment bought by PWCL last year at around HK$300,000)

- Purchaser testing on mass per metre
  - One/three test per diameter per batch [Table 10]
  - This is now a separate test, laboratories have to acquire HOKLAS accreditation

Implications (3/3)

- Exclusion of ‘Class 3 steel reinforcing bars’
  - No implication

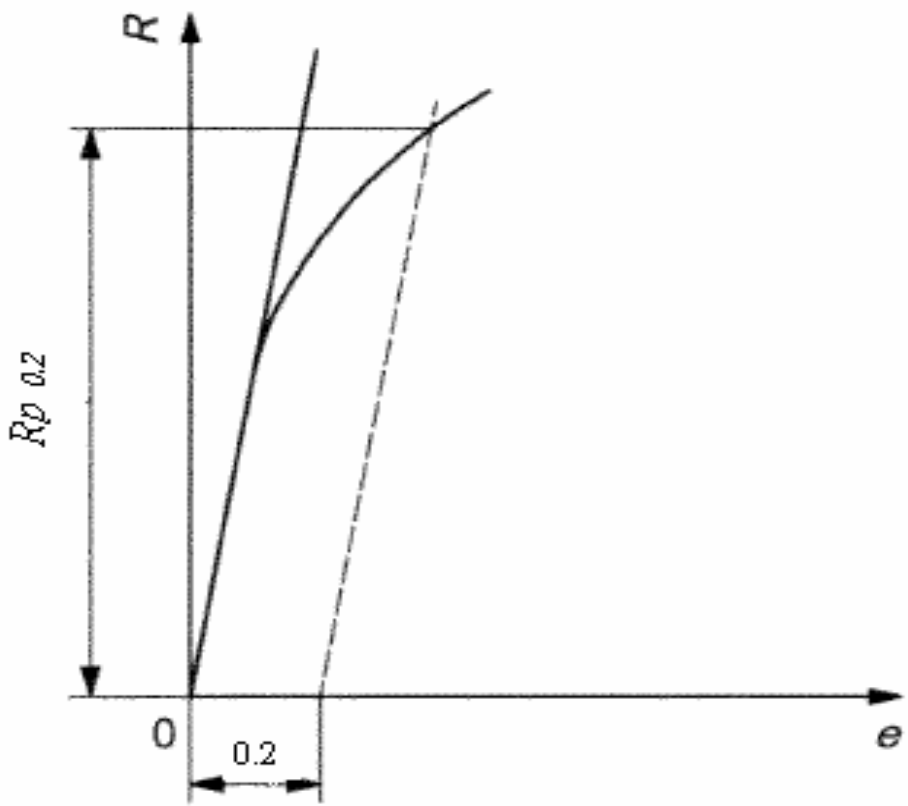
- Requirement for handling non-conforming steel reinforcing bars as part of the certification requirements for QA Stockists
  - The requirement helps to prevent any mal-practice of moving non-conforming steel reinforcing bars from site to site

Purchaser Testing (1/4)

- Determination of mass per metre explicitly required

- Tensile test
  - Upper yield strength (R_e) or 0.2% proof strength ($R_{p0.2}$)
  - Tensile strength (R_m)
  - Total elongation at maximum force (A_{gt})
  - Nominal cross-sectional area for calculating the tensile properties

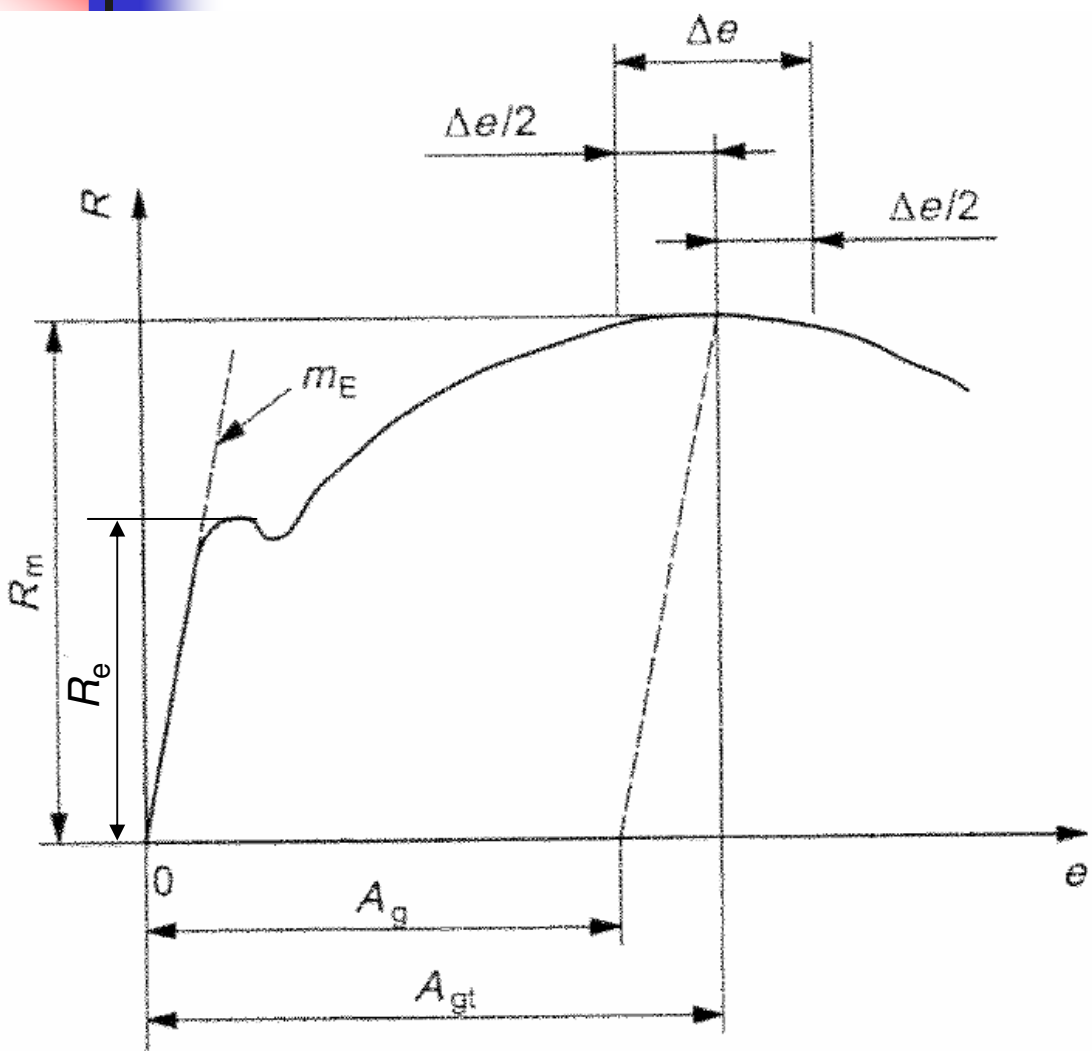
Fig. 10 - Proof Strength and Plastic extension



KEY

e	Percentage extension
R	Stress
$R_{p0.2}$	0.2% proof strength

Fig. 12 - Definition of Elongation



KEY

A_g	Percentage plastic elongation at maximum force
A_{gt}	Percentage total elongation at maximum force
e	Percentage elongation
m_E	Slope of the elastic part of the stress-percentage elongation curve
R	Stress
R_e	Yield stress
R_m	Tensile strength
Δe	Plateau extent (for determination of Ag and Agt, see Appendix B)

Purchaser Testing (2/4)

- Rebend test (bend test no longer required)
- Chemical analysis
  - C, Mn, Cr, Mo, V, Ni and Cu to arrive at the Carbon Equivalent Value (C_{eq}) and S, Ph and N
- Bond property
  - Surface geometry measurement or beam test

Purchaser Testing (3/4)

- Fatigue property is optional; to be required by projects where necessary

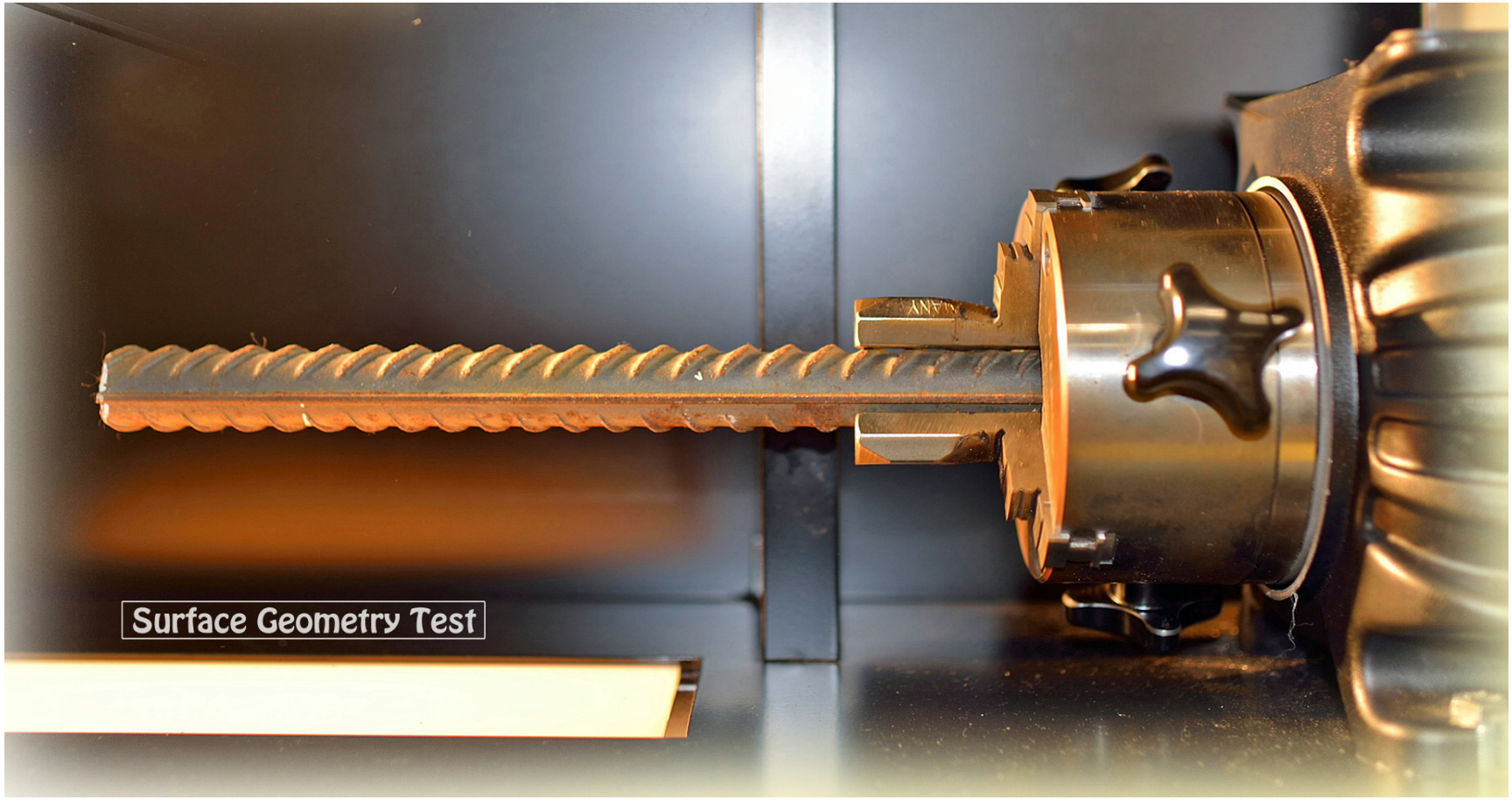
- Definition of ‘batch’ for purchaser testing
  - the quantity of steel reinforcing bars delivered to site within a week under one delivery order, of one nominal diameter, and one steel grade and produced by the same manufacturer
  - $\leq$ 200 tonnes for bars of diameter $\geq$ 20 mm
  - $\leq$ 100 tonnes for bars of diameter < 20 mm

Purchaser Testing (4/4)

- Testing frequency as stipulated in Table 10
- Retest allowed for mass per metre, chemical composition (product analysis), tensile strength, bend performance and bond property

Spectrometer for Chemical Composition Test

Laser Scanner for Surface Geometry Test



Implementation

- Public works:
  - Targeted for implementation on 1 January 2015 by specifying such in public works contracts
- Private building developments:
  - With the publication of the Code of Practice for Structural Use of Concrete 2013 by the Buildings Department on 28 February 2013, the CS2:2012 may be used with immediate effect

Other Information

- Soft copy (link):

  http://www.cedd.gov.hk/eng/publications/standards_handbooks_cost/stan_cs2_2012.htm

- Enquiry:

  The Secretary of the Standing Committee on Concrete Technology
  Civil Engineering and Development Department
  101 Princess Margaret Road
  Homantin
  Kowloon

Thank you