



Competence in Preloaded Bolting

BCSA Standard:

Level 1 – Bolting Practitioner

Level 2 – Bolting Inspector

Level 3 – Bolting Coordinator

Apart from any fair dealing for the purposes of research or private study or criticism or review, as permitted under the Copyright Design and Patents Act 1988, this publication may not be reproduced, stored, or transmitted, in any form or by any means, without the prior permission of the publishers, or in the case of reprographic reproduction only in accordance with terms of the licences issued by the UK Copyright Licensing Agency, or in accordance with the terms of licences issued by the appropriate Reproduction Rights Organisation outside the UK.

Enquiries concerning reproduction outside the terms stated here should be sent to the publishers, The British Constructional Steelwork Association Ltd. at the address given below.

Although care has been to ensure, to the best of our knowledge, that all data and information contained herein are accurate to the extent that they relate to either matters of fact or accepted practice or matters of opinion at the time of publication, The British Constructional Steelwork Association Limited, the authors and the reviewers assume no responsibility for any errors in or misinterpretations of such data and/or information or any loss or damage arising from or related to their use.

Publications supplied to members of BCSA at a discount are not for resale by them.

BCSA Limited is the national organisation for the steel construction industry: its Member companies undertake the design, fabrication and erection of steelwork for all forms of construction in building and civil engineering. Associate Members are those principal companies involved in the purchase, design or supply of components, materials, services etc related to the industry. The principal objectives of the Association are to promote the use of structural steelwork; to assist specifiers and clients; to ensure that the capabilities and activities of the industry are widely understood and to provide members with professional services in technical, commercial, contractual, quality assurance and health & safety matters.

The British Constructional Steelwork Association Ltd.,
4, Whitehall Court, Westminster, London SW1A 2ES.
Telephone: (0) 20 7747 8121 Fax: (0) 20 7976 1634.
E-mail: postroom@steelconstruction.org
Website: www.steelconstruction.org

ISBN 0 85073 *** *

British Library Cataloguing-in-Publication Data.

A catalogue record for this book is available from the British Library

© The British Constructional Steelwork Association Ltd

BCSA Publication No **/07

1 GENERAL

1.1 Preloaded Bolted Connections

Preloaded bolted connections are in general usage in steel bridgework and other heavy steel constructions. They are designed according to national and international standards and are, in general classified by the design performance of the completed connection.

The methods of managing the assembly of bolted connections are a critical stage in the construction and the following scheme provides for appropriate training, which will lead to qualification of personnel.

Leading bridgework companies and their bolt suppliers have in place training schemes, which create an awareness of the principles of structural connection, but there are no recognised common standards for performance demonstration within the industry. The objectives of this scheme are, with the aid of industry, to give confidence in the effectiveness of training through performance demonstration at the appropriate level.

1.2 Scope

The scheme provides for qualification for personnel at three levels: Level 1 Bolting Practitioner, Level 2 Bolting Inspector and Level 3 Bolting Coordinator. As developed below, the responsibilities are:

- Level 3 – Drafting of method statements;
- Level 2 – Inspection and control of preloading in practice;
- Level 1 – Working to a method statement for preloading.

1.2.1 Level 1

Level 1 personnel shall have a basic knowledge of the principles relating to the preparation and assembly of preloaded bolted connections and have the ability to:

- Understand the various types of preloaded fasteners in common use including:
 - High strength friction grip bolts
 - Tension control bolts
 - Direct tension indicators
- Prepare and maintain bolting equipment
- Work according to a prepared method statement to:
 - Prepare, for assembly, preloaded bolted connections
 - Assemble preloaded bolted connections
 - Tightening/tensioning bolt assemblies using appropriate equipment
 - Demonstrate safe working practices.

1.2.2 Level 2

In addition to the responsibilities applied to a Level 1, Level 2 personnel shall have the ability to:

- Have suitable knowledge of the relevant reference standards with respect to inspection of preloaded bolted connections (see References)

- Understand the function of bolts, tightening principles and factors that can influence the proper execution of preloaded bolted connections, including:
 - Equipment calibration
 - Condition of faying surfaces
 - Fit-up of the connection elements
 - Condition of the fastener assemblies
 - Storage and handling of fasteners
 - Tightening method and sequence
- Select, calibrate, prepare and maintain appropriate bolting equipment
- Direct and supervise Level 1 personnel implementing method statements on site
- Check assembled connections for compliance with specification.

1.2.3 Level 3

In addition to the responsibilities applied to a Level 1 and Level 2, Level 3 personnel shall have the ability to:

- Have suitable knowledge of all relevant reference standards and their implications for proper functioning of preloaded bolted connections (see References)
- Prepare a method statement for executing a preloaded bolted connection, covering:
 - Preparation for assembly the preloaded bolted connection
 - Assembly of the preloaded bolted connection
 - Specifying appropriate equipment
 - Tightening/tensioning bolts
 - Checking assembled connections for compliance with specification
 - Safe working practices.

1.3 Experience

The experience requirements for examination eligibility are:

1.3.1 Level 1

Candidates should have a minimum experience of six (6) month's experience in steelwork erection.

1.3.2 Level 2

Candidates should have a minimum experience of six (6) month's experience as a Level 1 Bolting Practitioner.

1.3.3 Level 3

Candidates should have a practical background in engineering practices with a minimum experience of twelve (12) month's experience in a steelwork related discipline.

Candidates must have successfully completed an approved course of training in preloaded bolted structural connections. Training courses shall encompass the topics of this syllabus.

2 EXAMINATION PROCEDURE

2.1 Level 1

Candidates are required to take a practical examination to demonstrate their proficiency in the preparation and assembly of preloaded bolted connections in accordance with an established method statement.

The examiner may require oral confirmation of steps during the process.

Level 3 Bolting Coordinators may conduct examinations and assess Level 1 candidates. No fees are payable.

2.2 Level 2

Candidates are required to take a practical examination to demonstrate their proficiency in the inspection of preloaded bolted connections in accordance with criteria referenced in an established method statement.

The examiner may require oral confirmation of steps during the process and of knowledge of the relevant standards for inspection.

Level 3 Bolting Coordinators may conduct examinations and assess Level 2 candidates. No fees are payable.

2.3 Level 3

Candidates are required to take theoretical and practical examinations.

The theory examination shall consist of 30 questions, which are of the single answer, multiple choice type.

The practical examination will require the candidates to prepare, assemble and complete preloaded bolted connections, using both torque and tensioning techniques, in accordance with an established method statement.

The examiner may require oral confirmation of steps during the process.

Examination of Level 3 candidates must be undertaken by independent assessors approved by the BCSA for which a fee is payable.

Candidates will be required to submit an application form and CV detailing appropriate experience. Application forms shall ask for specific details of experience and training and must be signed to the effect that such details are correct.

Any discovery of false statements on forms or CV's shall render any examination null and void.

Non-payment of fees shall render any certificate invalid irrespective of the results of examination.

3 VALIDITY

3.1 Successful Level 3 candidates

Two copies of a certificate of proficiency will be issued on behalf of BCSA by the assessor or approved assessment organisation. These will be issued to the organisation or person that pays the examination fee. Duplicate certificates to replace those lost or destroyed will only be issued after extensive enquiry.

3.2 Unsuccessful Level 3 candidates

Candidates who fail to obtain a certificate may attempt one retest on those parts of the examination in which success was not achieved. The retest must be completed within one year of the initial examination; otherwise candidates will have to repeat the complete examination.

The retest (or complete examination) may not be taken within 30 days of the previous examination unless the candidate can provide documented evidence of further approved training in those areas of candidate knowledge deficiency.

3.3 Period of validity

3.3.1 Levels 1 and 2

Organisations employing and assessing competence of Level 1 Bolting Practitioners and Level 2 Bolting Inspectors shall re-assess their competence every three years.

3.3.2 Levels 3

Certificates are valid for three years from the date of completion of the initial test and may be renewed for a further three years on application, provided evidence is produced in accordance with Clause 3.4.1.

Certificates are only valid provided:

- they are within date
- they are on paper bearing the BCSA logo. The certificate must also be signed by an officer of BCSA.
- they have been signed by the individual to whom the certificate is awarded
- they are accompanied by a valid CSCS identity card.

PHOTOCOPIES ARE UNAUTHORISED BY BCSA AND SHOULD ONLY BE USED FOR INTERNAL ADMINISTRATION PURPOSES.

3.4 Renewal

For the certificate to be renewed after three years the holder has to demonstrate that competence has been maintained by providing evidence of continuous work activity in the coordination of preloaded bolted connections.

This can be satisfied by the submission of method statements prepared by the candidate for relevant work activity covering the period of validity of the certificate.

The certificate will not be renewed without further test if the BCSA receives an authenticated complaint during the period of validity. Further instruction and retest may then be required.

Renewal must take place not later than 21 days after the expiry date of the certificate. The certificate holder is responsible for ensuring that renewal takes place at the appropriate time. In extreme circumstances a late renewal may be allowed, subject to payment of a special fee.

3.5 Complaints and appeals

An aggrieved party in a dispute which considers itself to have reasonable grounds for questioning the competency of a certified Level 3 Bolting Coordinator may petition the BCSA for cancellation of the certificate. Such a petition must be accompanied by all relevant facts, and if in the opinion of the BCSA an adequate case has been presented, a full investigation of the circumstances under dispute will be initiated. If the petition is substantiated to the satisfaction of the BCSA, the certificate will not be renewed without further test.

Appeals against failure to certify or against non-renewal of the certificate may be made by the practitioner or the employer upon application in writing to the BCSA.

3.6 Records

3.6.1 Levels 1 and 2

Employers shall keep records of the assessments and the identity of the Level 3 Bolting Coordinator undertaking the assessments.

3.6.2 Level 3

Independent assessors or assessment organisations approved by BCSA shall maintain records of Level 3 assessments undertaken for both successful and unsuccessful candidates. These records shall be accessible to the BCSA on request.

4 REFERENCES

BS 4395-1 and -2
BS 4604
BS 5400-6
BS EN 14399-1 to -10
BS EN 1090-2 (currently in draft)
BS EN 1991-1-8
SCI Guidance Notes 2.06 and 7.05

APPENDIX: EXAMINATION SYLLABUS

1 Bolting Practitioner

1.1 Practical

Preparation and assembly of and tightening / tensioning a preloaded bolted connection in accordance with a provided method statement.

1.2 Background knowledge

In verbal interview, candidates will need to demonstrate sufficient knowledge of:

Terminology

High strength bolts, friction grip connections, tension control bolts, direct tension indicators, nut- and bolt-face washers, torque, tension, bolt and connection classification, faying surface.

Materials

Plate connection elements, bolting materials and classification, washer types, lubricants.

Preparing preloaded bolted connections

Interpretation of technical data on structural connections, connection and assembly methods, identification of materials against specifications, examination of materials for damage, cleanliness, distortion and surface irregularities, actions to be taken when irregularities are found.

Assembling preloaded bolted connections

Alignment of connection elements, bolt hole alignment, inspection of faying surfaces, selection and fitting washers as appropriate, correct fitting of nuts.

Tightening methods

Mechanical torque wrenches, controlled torque tightening with advantages and disadvantages, lubrication effects, tightening / tensioning sequences and passes, accuracy and consistency of technique.

Safety

General overview of safety and health, using PPE, safe use of hydraulic, electrical and compressed air equipment, potential hazards of tightening, handling of equipment and materials.

2 Bolting Inspector

2.1 Practical

Inspection of three preloaded bolted connections undertaken using three different methods, and identification of defects that might occur and methods of rectification.

2.2 Theory

In verbal interview, candidates will need to demonstrate sufficient knowledge of the Level 1 syllabus plus:

Specifications or parts of specifications relevant to inspection

See References and manufacturers' data sheets for proprietary preloadable fasteners.

Inspection checks

Checking of fastener seating and gaps between connection elements, completion of inspection sequence, data analysis, reporting and documentation. Operation of sequential methods for fastener inspection.

Measurement methods

Principles and techniques of tension, torque and part-turn measurement. Dimensional checking of fit-up of connections.

Preparation and maintenance of equipment

Identification, checking and calibration of torque wrenches, bolt tensioners, hydraulic equipment, compressed air and electrical power. Use of load cells. Test procedures for fasteners under site conditions. Capacity of selected equipment for work in hand, routine maintenance and remedial actions. Quarantine procedures.

Bolt tightening / tensioning

Equipment selection, fitting connection and adjustment of equipment, safe application and maintenance, completion of tightening sequence and subsequent passes.

3 Bolting Coordinator

3.1 Examination

Theory Part 1

Specific theory and product technology. 30 multiple choice questions (see 3.3). Time allowed 45 minutes.

Theory Part 2

Complete a method statement using an outline proforma. Time allowed: 45 minutes.

Practical Part 1

Preparation and assembly of and tightening / tensioning a preloaded bolted connection in accordance with a provided method statement. Time allowed: 45 minutes.

Practical Part 2

Inspection of a preloaded bolted connection and verification of compliance with the specification. Time allowed: 30 minutes.

Passmark for all parts is 70%

Time is allowed in the practical parts of the examination for the completion of any required documentation.

3.2 Subjects

Candidates will need to demonstrate knowledge of the Level 1 and 2 syllabuses plus:

Specifications

See References and manufacturers' data sheets for proprietary preloadable fasteners.

Functions of bolts

Elongation and yield, length/diameter ratios, bolt loading and deformation, applied and residual bolt loads, bolt relaxation, effects of time and environmental conditions on connections.

Fit-up of connections

Specified tolerances Effect of fit-up on proper functioning of preloaded bolted connections.

3.3 Specimen questions for Theory Part 1

- 1 The term 'HSFG' refers to:
 - a) hollow section friction group
 - b) high strength faying grease
 - c) high strength friction grip
 - d) high specification friction gun

- 2 Tightening of a tension control bolt is undertaken by:
 - a) tensioning using a torque control device
 - b) spline end fracture
 - c) a direct tension indicator
 - d) none of the above

- 3 A bolt has a load applied to the extent that it is permanently deformed. This bolt is said to have exceeded its:
 - a) plastic limit
 - b) elastic limit
 - c) ultimate tensile strength
 - d) load limit

- 4 Fastener assemblies tightened using direct tension indicators have:
 - a) a precise regulation of the applied load
 - b) partial regulation of the applied load
 - c) no regulation of the applied load
 - d) a guarantee of in-service performance

Drafting Note: These are not particularly good questions but they give an idea of the level expected.