ACCREDITATION SCHEME FOR
CERTIFICATION BODIES

CT 28

SAC CRITERIA FOR SPECIALIST BUILDERS (GROUND SUPPORT AND STABILISATION WORKS FOR ERSS)

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CONTENT

1. INTRODUCTION

1.1 The purpose of certification of Specialist Builders ("SB") on ground support and stabilisation works (Defined in part (b) of "Specialist building works" in Section 2 of the Building Control Act) as listed in Table 1.3 is to ensure these specialist ground support and stabilisation works related to Earth Retaining and Stabilising Structures ("ERSS") conforms to standards and/or other normative documents (See Appendix 1).

1.2 This document specifies the required quality management system, project quality plan, competencies (manpower and machinery) and the appropriate procedures or methods to execute ground support and stabilisation works for ERSS with good quality, and durability for certification of SBs.

1.3 The field of specialist ground support and stabilisation works for ERSS covers various types of products as listed below:

Table 1.3: List of Products of Ground Support and Stabilisation Works for ERSS

Item	Type
1	Ground Anchors
2	Soil Nails
3	Rock Bolts
4	Jet Grouting
5	Deep Soil Mixing (e.g., GMP wall)
6	TAM Grouting
7	Fissure Grouting
8	Reinforced Fill
9	Sprayed Concrete [SC] / Sprayed Fibre Reinforced Concrete [SFRC]

1.4 Ground support and stabilisation works not listed in the above table are not covered in this document.

1.5 Certification is granted to SBs of the specific ground support and stabilisation work(s) as categorised in Table 1.3. based on the demonstration of the continuing operation of the quality management system consistent with ISO 9001 together with the ability to supply and install the products in accordance with the standards in Appendix 1 upon successful audit by a Certification Body ("CB") accredited by SAC.

1.6 Products listed in Table 1.3 are to be carried out by certified SBs. Where the products are subcontracted in part or in whole, the subcontractor shall also be a certified SB.

2. MACHINERIES

2.1 For the purpose of certification, a SB for the respective ground support and stabilisation works shall have the relevant machineries and own not less than the minimum number of such machineries shown in table 2.1.

Table 2.1: Machinery Requirements

Type of Ground Support and Stabilisation Works	Types Machinery	Minimum Number
1) Ground anchor, soil nail, rock bolt	Drilling rig with accessories, Stressing equipment (for ground anchor)	2 sets each
2) Ground treatment (e.g., DCM / JGP / TAM / Fissure Grouting etc.)	Relevant rig with accessories	2 sets each
3a) Reinforced fill and soil wall, slope and embankment 3b) Slope stabilisation with geosynthetics 3c) Pavement and ground support and stabilisation works with geosynthetics	Compaction equipment	2 sets (SBs may not own, but shall demonstrate that they have the arrangement to access the equipment)
4) Sprayed Concrete / Sprayed Fibre Reinforced Concrete	Shotcrete machine spraying equipment	2 sets

2.2 The machineries are to be subject to a regular maintenance regime by a dedicated maintenance team. SBs are to keep the maintenance records for at least 3 years and maintain such regular maintenance team to ensure machineries are always in good conditions for use.

3. PRODUCTS

3.1 All products and its material shall meet the requirements set in the respective EN standards. Where there is no relevant EN / ISO / EN-ISO standard for the products and its material, any established national standards may be provided to substantiate the quality and consistency of the products and its material and will be subject to approval by BCA under alternative solution. The information for the products and its material shall be documented.

4. TESTS

4.1 The following tests shall be carried out on ground support and stabilisation works for ERSS produced by the SBs to demonstrate to the auditors that these ground support and stabilisation works for ERSS as products have been executed in accordance with the relevant requirements of the execution codes and standards.

Table 4.1: Pre and Post Installation Tests

Item	Products	Pre installation Tests	Post Installation Tests
1	Ground Anchors	• Tensile strength of strand/reinforcement • Strength of grout • Locking system of wedge	• Acceptance test
2	Soil Nails	• Tensile strength of rod/reinforcement • Strength of grout	• Production nail test
3	Rock Bolts	• Tensile strength of bolt • Strength of grout	• Production bolt test
4	Jet Grouting (production)	• Characteristic of grout	• Grouted level (top/bottom) • Overlapping check (mass grouting) • Column diameter (individual column grouting)[#] • Strength, stiffness and permeability test of core sample as required
5	Deep Soil Mixing (e.g., GMP wall)^ (production)	• Characteristic of grout	• Grouted level (top/bottom) • Overlapping check (mass grouting) • Strength, stiffness and permeability test of core sample as required
6	TAM Grouting (production)	• Characteristic of grout	• Grouted level (top/bottom) • Strength, stiffness and permeability test
7	Fissure Grouting (production)	• Characteristic of grout	• Permeability test
8	Reinforced Fill	• Tensile strength and interface friction for reinforcement • Specification of Fill material	• Degree of compaction • Monitoring of reinforced fill structure performance*
9	Sprayed Concrete / Sprayed	• Trial test of sprayed concrete strength (core test)	• Thickness check

Item	Products	Pre installation Tests	Post Installation Tests
	Fibre Reinforced Concrete	• Tensile strength of reinforcement / fibre	

^ For grouting methods where the grouting diameter is larger than the blade, column diameter shall be checked

Coring recommended to be carried out at ~1/3 radius from the outer diameter of jet grout column

* Reinforcement should be instrumented to monitor the performance of reinforced fill structure, if required by QP(D) or QP(S).

4.2 In addition, the SBs are to declare to the Auditors all the tests carried out in the past 3 years. They shall declare the tests that have failed from among all the tests carried out. Test reports, corrective and preventive measures for those failed tests should be shown to the Auditors accordingly during the audit. Where tests can be conducted by accredited laboratories, such tests shall be carried out accordingly.

5. PERSONNEL

5.1 GENERAL REQUIREMENTS

5.1.1 SBs' personnel shall be suitably qualified and have sufficient experience in their scope of the relevant products.

5.1.2 SBs' personnel must be familiar with the standards or codes used for ground support and stabilisation works. The Technical Managers and Engineers are required to attend the relevant training courses prior to the application for certification under the Scheme for SBs.

5.1.3 SBs shall maintain records of key personnel's qualifications, training and experience.

5.2 QUALIFICATION CRITERIA

The criteria stated in Table 5.2 shall be fulfilled by the personnel performing the respective roles.

Table 5.2: Qualifications of Personnel

Designation	Role	Required Experience and Qualifications
Technical Manager^ (TM)	Provide technical guidance on (where applicable): - Soil and rock identification on-site - Computation of bored length on site to achieve design working load - Appropriate measures for drilling in geologically complex ground	- Degree in Civil Engineering with at least 3 years of experience in relevant works for degrees that are recognised by the Professional Engineer Board of Singapore or 5 years of experience for any others; **and** - PE^ or Chartered Engineer (Infrastructure)^ ("CE") with relevant knowledge and experience in ground support and stabilisation works for ERSS; **or** - If the TM is not a PE or CE, the company has to engage a PE* or CE* as supervising PE or CE. In this case, the TM^ is designated as PE or CE representative. ** The PE or CE may be part time and should serve only one SB (ground support and stabilisation works) at a time.* *SB shall inform CB when there is a change of PE or CE. Certification will be suspended when the PE or CE is absent. If the PE or CE is absent for more than 3 months, the Certification will be withdrawn.*
Engineer^	Ground anchor / soil nail / rock bolt and the like - Perform anchor/nail/bolt length computation Grouting - Perform relevant quality control test General - Perform relevant quality control test	- Degree in Civil Engineering recognised by Professional Engineer Board of Singapore; **or** equivalent - or any other Degree in Civil Engineering with at least 2 years of relevant experience
Geologist	- Soil and rock identification	- Bachelor of Geology with at least 2 years of experience in soil/rock classification in local context; **or** - Engineer with Degree in Civil Engineering recognised by Professional Engineer Board of Singapore with at least 3 years of experience in soil/rock classification in local context -
Site Supervisor	- Day to day supervision of ground support and stabilisation works	- Minimum Diploma in Civil Engineering, Geology, Built Environment and related discipline, with at least 2 years of experience in ground support and stabilisation works; **or** - Five years working experience as specialist for ground support and stabilisation works -
Various Rig Operator	- Day to day operation of piling rigs	- For certification requirement, at least 3 years of experience as a rig operator; **and** - Operator should possess relevant experience in ground support and stabilisation works

^ To have attended at least 6 hours of accumulated training provided by accredited training organisations in subject(s) related to the relevant field of ground support and stabilisation work. This training will be supported by the certificate of attendance and course brochure/synopsis.

5.3 MINIMUM NUMBER OF REQUIRED PERSONNEL

SBs shall have adequate manpower resource to ensure the quality of its works. The **minimum** number of personnel for **each SB** is summarised in the table below.

Table 5.3: Minimum Number of Personnel

Item	Product	Technical Manager*	Engineer*	Site Supervisor*	Geologist	Rig Operator
1	Ground Anchors	1	1	1	-	1
2	Soil Nails				-	
3	Rock Bolts				1	
4	Jet Grouting				-	
5	Deep Soil Mixing (e.g., GMP wall)				-	
6	TAM Grouting				-	
7	Fissure Grouting				-	
8	Reinforced Fill				-	-
9	Sprayed Concrete / Sprayed Fibre Reinforced Concrete				-	-

*Where the TM/engineer/site supervisor does not have the relevant experience for a specific product, a separate TM/engineer/site supervisor with the required experience of that product is to be engaged.

6. REPORT FOR GROUND SUPPORT AND STABILISATION WORKS

6.1 The PE or CE shall review and endorse the list of records (those specified in EN Codes). The Technical Manager shall ensure that the report contains all the information attached in Appendix 2 where applicable.

7. INSTALLATION PROCEDURES

7.1 SBs shall have detailed procedures, method statements and instructions for the application of the appropriate regulations, codes of practice, standards, specifications, guidance documents and customer requirements.

7.2 SBs applying for certification in their respective categories shall comply with the relevant BS EN Standards, where applicable, for ground support and stabilisation works:

BS EN 1537	Execution of special geotechnical works – Ground Anchors
BS EN ISO 22477-5	Testing of grouted anchors
BS EN 14490	Execution of special geotechnical works – Soil nailing
BS EN 12715	Execution of special geotechnical works – Grouting
BS EN 12716	Execution of special geotechnical works – Jet Grouting
BS EN 14679	Execution of special geotechnical works – Deep mixing
BS EN 14475	Execution of special geotechnical works – Reinforced fill
BS EN 14487	Sprayed Concrete. Definitions, specifications and conformity
BS EN 14488 (all parts)	Testing sprayed concrete
EN 16228 (all parts)	Drilling and foundation equipment – Safety

7.3 SBs shall be competent and able to perform the type of ground support and stabilisation works within their scope of specialist works according to BS EN execution standards.

8. QUALITY CHECKS

8.1 SBs shall make arrangement on the type of quality tests required as per the below table during the on-site audit by Auditors appointed by the CB.

Table 8.1: Quality Checks

Quality Tests (Refer to Table 4.1)	Initial and Recertification
1) Ground Anchor / Soil Nail / Rock Bolt	1 for each test^
2) Jet Grouting / Deep Soil Mixing / TAM / Fissure Grouting	1 for each test^
3) Reinforced Fill	1 for each test^
4) Sprayed Concrete / Sprayed Fibre Reinforced Concrete	1 for each test^

^ Report of the test(s) carried out by third party laboratory shall be submitted to the CB either during the on-site audit, or where applicable, a later date for test on sample(s) taken during the on-site audit for consideration in its certification decision.

8.2 For new builders applying for certification or existing SBs applying for recertification that had fulfilled all certification criteria but has yet to demonstrate compliance through on-site audit by the CB due to the lack of suitable on-going projects, the on-site audit of the quality tests as per Table 8.1 may be conducted on a later date. Under such circumstances, a letter of precertification may be granted.

The SB undertakes to inform the CB as soon as a suitable contract is awarded and to arrange for the CB to carry out the on-site audit within 3 months of work commencement.

The precertification letter shall be valid for a period of one year but may be reissued for another year.

9. QUALITY MANAGEMENT SYSTEM

9.1 QUALITY MANAGEMENT SYSTEM REQUIREMENTS

9.1.1 SB shall operate a quality management system that complies with ISO 9001 and this schedule. This schedule interprets those elements that are particularly relevant to the installation of ground support and stabilisation works to ensure consistent product quality and continued compliance with this schedule.

9.1.2 If the Quality Management System of the SB has been certified to ISO 9001 by a CB accredited by SAC or an IAF Multilateral Recognition Arrangement (MLA) partner, SB may use the accredited certificate in support of the certification SB (ground support and stabilisation works).

9.2 QUALITY MANAGEMENT SYSTEM PLANNING

9.2.1 SB shall produce a quality plan for each structure, contract or project as appropriate and identifying specific details on which it is contracted to operate.

9.2.2 This plan shall include method statements and inspection test plans for all key ground support and stabilisation works activities. The minimum scope for a quality plan and inspection test plan is given in Section 9.2.4 and 9.2.5.

9.2.3 The quality plan shall identify the human resources including training and certification for site crews, responsibilities, hold points (and release authorities), processes, materials, equipment, controls, inspection, measuring and test equipment, reference standards and levels of acceptability required to meet the contract requirements.

9.2.4 QUALITY PLAN

9.2.4.1 SB shall produce a documented quality plan, which covers general ground support and stabilisation works operations and specific site requirements. To ensure a degree of consistency between organisations, the quality plans shall include the following:

1. The requirements of this schedule, ISO 9001.
2. The definition and identification of contract specific requirements and related documents including internal and external audit reporting requirements.

3. A definition of the organisational responsibilities and authorities, particularly those pertaining to verification activities.
4. The resource requirements including processes, materials and equipment.
5. The identification and status of site personnel.
6. The approval and verification requirements of purchased services and material.
7. A procedure for reviewing the work programme, adjustments to the work programme and records of programme review.
8. Procedures for office activities including communication between the office and site.
9. Method statements relating to site activities, including work instructions, quality procedures, records, inspection and test arrangements and work acceptance procedures.
10. Procedures for the control of site documentation.
11. Procedure for dealing with non-conformances.
12. Procedures to train and certify the site crews and keep records to demonstrate that all personnel working on site are adequately and appropriately trained and certified.
13. Procedures for quality audit and management review of the implementation of the quality plan.
14. The identification of hold points, the verification required, the verification responsibilities and the authority for release.
15. The selection and employment of suppliers.
16. A review of the completed contract including an analysis of defects.

9.2.5 INSPECTION TEST PLAN (ITP)

9.2.5.1 SB shall produce a documented inspection and test plan for each project. The minimum requirements of such a document should include:

1. The various stages of installation, referencing the control/inspection records and clearly defining acceptance criteria
2. Responsibilities for completion of the records (Job title/position)
3. Responsibilities for checking of the records (Job title/position), if applicable
4. The identification of “hold points” where applicable at each installation stage
5. The identification of the responsible individuals to release to the next stage
6. The identification of the records necessary to allow release to the next stage
7. The method of release (signature, email etc)

9.2.5.2 Such information may be provided in tabular form or in a flow diagram but shall provide sufficient clarity to ensure the requirements of this schedule are met.

9.2.5.3 Documents used for recording of the installation shall be controlled with appropriate document reference numbers and version control where necessary.

9.2.5.4 All records of the installation and release signatures shall be made available for inspection on site or during office audits (in cases of completed projects) and stored appropriately in line with requirements of this schedule.

10. SAFETY AND ENVIRONMENTAL REQUIREMENT

10.1 Staff on-site shall have the requisite Personal Protection Equipment, for example, safety helmet, safety shoes and any other safety equipment as deem necessary by the site safety officer.

10.2 SBs shall have procedures to ensure the safety of its staff and the general public.

10.3 SBs shall ensure that they comply with relevant regulatory requirements with regard to environmental issues.

11. RECORDED DATA AND OTHER DOCUMENTS

11.1 The records of ground support and stabilisation works shall be retained for at least 4 years unless legal obligations require longer period (refer to relevant EN standards)

12. REFERENCE

a)	BS EN 1537	Execution of special geotechnical works – Ground Anchors
b)	BS EN ISO 22477-5	Testing of grouted anchors
c)	BS EN 14490	Execution of special geotechnical works – Soil nailing
d)	BS EN 12715	Execution of special geotechnical works – Grouting
e)	BS EN 12716	Execution of special geotechnical works – Jet Grouting
f)	BS EN 14679	Execution of special geotechnical works – Deep mixing
g)	BS EN 14475	Execution of special geotechnical works – Reinforced fill
h)	BS EN 14487	Sprayed Concrete. Definitions, specifications and conformity
i)	EN 16228 (all parts)	Drilling and foundation equipment — Safety

Appendix 1

Scope of certification:

Type of Product	Type and Range of Installation Method	Installation Method, Codes or Standards Used
1) Ground anchors, soil nail and rock bolt	Execution of special geotechnical works A) Ground Anchors B) Soil Nail	BS EN 1537 BS EN ISO 22477-5 BS EN 14490
2) Reinforced fill	Execution of special geotechnical works A) Reinforced Fill	BS EN 14475
3) Jet Grouting/ Deep Mixing / TAM / Fissure Grouting	Execution of special geotechnical works A) Grouting B) Jet Grouting C) Deep Mixing	BS EN 12715 BS EN 12716 BS EN 14679
4) Sprayed Concrete / Sprayed Fibre Reinforced Concrete	Sprayed concrete on SCL tunnel and soil nail facing	BS EN 14487 BS EN 14488 (all parts)

Appendix 2

The following information is to be included in the report together with the records of the products and the associated tests. (site records of execution, supervision, monitoring, reports and as-built plans)

1. Identification of the document, i.e., date of issue and unique identification.
2. Identification of the client, consultants and subcontractors (if any).
3. Description of the project, products and the type of tests conducted.
4. Description of the machine/equipment, methods and procedures adopted for the installation of the products and the associated tests.
5. Name of the full staff members and supervisory team who installed the products and the associated tests.
6. Date of products installed.
7. Date of tests conducted.
8. The reports/results of tests, including field tests, laboratory tests, findings and issues encountered.