Approval & Reception Procedure

DEE – Departamento de Estruturas e Edifícios		
Quality Control of Steel Structure Engineering	Document no.	**ARP/DEE/005**
	Date:	**2019/06/21**
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1. General

- Steel structure work shall comply with Macau Code of Steel Structure for Buildings (REAE) and project's technical specifications / contract rules.
- Allowances shall be made for the deformation due to permanent loads and the all processes such as fabrication, delivery, erection, and construction so that the steelworks is completed to within the specified tolerances.
- The compatibility of the dimensions and setting-out data of steelwork shall be verified by the Contractor before the materials for steelwork are ordered.
- Use materials other than those materials given in Macau Code of Steel Structure for Buildings (REAE) and project's technical specifications / contract rules, the contractor shall submit the verification materials or calculations to design unit for approval. Unless otherwise specified or agreed by design unit, the latest version standards should be used priority.

2. Submission

2.1 The 1st stage - Before the steel structure production

2.1.1 Shop detail drawings

- The contractor shall submit shop detail drawings. The shop detail drawings shall include at least the following information:
  - Drawing catalogue and general overview;
  - Steel structure layout and detailed drawings, including steel type, dimension, number of bolts, welding details, weld quality grade, coating system, etc.; Detailed drawing of installation node;
  - Detailed drawing of the components;
  - Temporary welding position and removal requirements.

2.1.2 Method statement of production and construction

- The contractor shall submit method statement of production and construction. The method statement shall include at least the following information:
  - Steel structure production plan;
  - Transportation plan;
  - The sequence and method of installation;
  - Lifting plan;
  - Method of protecting coating;

2.1.3 Mill certificates of steel materials(steel materials, welding consumables, bolt system and anchor bolt)

- Mill certificates of steel materials shall include at least the following information:
  - Manufacturer, mill certificate number, steel section dimension, grade, and standards , heat number, mechanical properties, chemical composition and weldability.
  - Mill certificates of welding consumables shall include at least the following information: 焊 Manufacturer, mill certificate number, dimension, grade, and standards , mechanical properties, chemical composition.
- Mill certificates of bolt system shall include at least the following information:
  - Manufacturer, mill certificate number, grade, and standards , mechanical properties, chemical composition.
- The detail requirements of anchor bolts can be found in the ARP/DEE/009.

2.1.4 Welding procedure specifications (WPS) and welding procedure qualification record (WPQR)

- Submit welding procedure specifications (WPS) and welding procedure qualification record (WPQR) according to the corresponding joint type and welding process in the project.
- Welding procedures specification (WPS) shall be in accordance with EN ISO 15609 or AWS D1.1, or other equivalent standard approved by the design unit.
- Welding procedure qualification record (WPQR) shall be in accordance with EN ISO 15614 or AWS D1.1, or other equivalent standard approved by the design unit.
- WPS and WPQR shall be endorsed by a qualified 3rd party laboratory with stamp and signature.

2.1.5 Welder certificates (including fabrication factory and in site)

- Submit welder certificates according to the welding process in the project.
- The welder certificates shall include at least the following information:
  - Certificates are issued by a qualified institution; ;
  - Standard in accordance with BS EN 287, or EN1418, or BS EN ISO 9606-1, or AWS D1.1 , or other equivalent standard;
  - The certificates have the approved welding range and within the validity period.

2.1.6 Fabrication Factory Information

- The following information about steel structure fabrication factory should be submitted:
  - Catalogue and job references;
  - Certificate of quality management system;
  - Organization chart;
  - Quality control plan: The plan should show the responsible department of the factory for the quality control work, procedure of quality control, the sampling frequency and the conformity and acceptant criteria for material tests, welding tests, coating tests, dimension checking are in accordance with the Macau Code of Steel Structure for Buildings (REAE) and related contract specifications;
  - The recently quality auto-control documents of fabrication factory: including incoming material inspection record, quality inspection record of component production, welding inspection record, non-destructive inspection records of welds, quality inspection record of shear stud, component dimension inspection record, pre-assembly quality inspection record, etc;
  - Test equipment, personnel qualification, calibration certificate of the instrument, etc. of quality control department of fabrication factory;
  - Valid and approved welder certificates;
  - Approved welding procedure specification (WPS) and welding procedure qualification records (WPQR).
- Depending on the actual situation, inspections on the factory will be required to verify the technical and quality competence for the project.

2.1.7 Galvanization factory information

- The following information about galvanization or zinc spraying factory information should be submitted:
  - Catalogue and job references;
  - Certificate of quality management system;
  - Organization chart;
  - Dimension of galvanized bath tanks;
  - Method statement of galvanizing or zinc spraying processes;
  - Quality control manual for each process;
  - Source and quality of zinc;

- Valid calibration certificate of temperature and humidity control systems;
- The recently quality auto-control documents of factory;
- Test equipment, personnel qualification, calibration certificate of the instrument, etc. of quality control department of factory;

➢ Depending on the actual situation, inspections on the factory will be required to verify the technical and quality competence for the project.

2.1.8 Coating Information

➢ The coating information shall include at least the following information:
- The recommended paint system should indicate the location of the work, the environmental conditions, the type of substrate material, the amount and type of coating, and the nominal dry film thickness of each layer of coating;
- Technical catalogue and job references;
- The manufacturer's data sheet should include temperature, humidity and other conditions suitable for painting in the workshop or on site;
- Detailed method statement for the painting systems, include substrate preparation, with suitable protecting works, application method and work procedures through to the cleaning of the completed.

2.1.9 Inspection and testing plan（ITP） (Included fabrication factory and on site)

➢ The quality control work of the steel structure shall be detailed, and shall include the quality auto-control items of the fabrication factory (such as incoming material inspection, blanking and cutting, component dimension, welding inspection, welding test, etc.) and reception test items which carry out by third-party laboratory (such as material mechanical properties, welding test, galvanizing thickness, coating thickness, etc.). It should also state that the sampling frequency and the conformity and acceptant criteria for material testing, welding test, coating test, dimensional inspection are in accordance with the Macau Code of Steel Structure for Buildings (REAE) and related contract specifications.

2.1.10 3rd party laboratory

➢ In general, the 3rd party laboratory are recommended to be accredited by international bodies (such as CNAL, HOKLAS), and the test methods are also accredited. The following information of 3rd party laboratory should be submitted for approval:

- Catalogue and job references;
- Accredited certificates;
- Accredited test list;
- The valid certificates of welding inspector to be used in the project.

➢ Test methods that are not accredited by internationally bodies (such as CNAS, HOKLAS). The following information should be submitted for approval, and the witness of related test is required.

- Catalogue and job references;
- The procedure of test method;
- The valid calibration certificate of test equipment;
- The valid certificates of inspector to be used in the project. (if need)

2.2 The 2nd stage - Component arrived on site

2.2.1 Component delivery note

➢ The number and quantity of the components which arrived on site should be listed.

2.2.2 Quality auto-control records of fabrication factory

➢ The submitted quality auto-control records shall be traceable to the details of fabrication in the factory and include at least the following information:

- Traceable statistical table of quality control documents;
- Incoming material records;
- Mill certificates;
- Inspection records of incoming material;
- Quality inspection records of component production;
- Welding inspection records;
- Non-destructive testing records of welds;
- Quality inspection records of shear stud;
- Component dimension inspection records;
- Pre-assembly quality inspection record;
- Galvanized thickness measurement records;
- Coating measurement records.

2.2.3 Reception test reports which issued by 3rd party laboratory

- Test reports of material mechanical properties;
- Chemical composition test reports of stainless steel materials;
- Non-destructive testing reports of welds;
- Bend test reports of shear stud;
- Galvanized layer thickness measurement reports;
- Galvanized layer uniformity test reports;
- Coating thickness measurement reports (the thickness of the coating with different layers of primer, intermediate paint and topcoat should be distinguished)
- Coating adhesion test report.

2.3 The 3rd stage - Site assembly and completed

2.3.1 Site records

- Incoming material records;
- Component arrived records and visual inspection records
- Assembly records;
- Lifting records;
- Welding records;
- Bolt tightening record;
- Coating records.

2.3.2 Reception test reports which issued by 3rd party laboratory

- Test reports of material mechanical properties;
- Chemical composition test reports of stainless steel materials;
- Non-destructive testing reports of welds;
- Coating thickness measurement reports (the thickness of the coating with different layers of primer, intermediate paint and topcoat should be distinguished);
- Bend test reports of shear stud;
- Inspection report on final torque of set of high strength bolt;
- Anchor bolt pull-out test reports.

3. Quality control

3.1 General

- Quality control shall comply with Macau Code of Steel Structure for Buildings (REAE) and project's technical specifications / contract rules.
  - If the project's technical specifications / contract rules state the requirements for quality control, the quality control shall comply with the stricter requirements between the project's technical specifications / contract rules and the requirements of the ARP.
  - If the project's technical specifications / contract rules don't state requirements for quality control, the quality control shall comply with the requirements of the ARP.
  - Reception test should be carried out by the approved 3rd party laboratory
  - For the reception test in overseas/inland fabrication factory, the witness of sampling work shall be carried out by the approval 3rd party laboratory.

3.2 Reception of steel material

- The sampling of steel materials as following: provide at least one test specimen for every 40 tones of each section of same thickness from the same cast. For this purpose the "same thickness" means similar sections with a variation in thickness not exceeding 5 mm. Test specimens to be taken from sections selected at random on site. Reception test item of steel materials as show table 1.

Table 1 Reception test item of steel materials

Test Item	Standard	Remarks
Tensile Test (Yield Strength, Tensile Strength and Elongation)	EN 10002-1、BS EN ISO 6892-1	
Charpy Impact Test	EN 10045-1、BS EN ISO 148-1	a)
Chemical composition Test	EN 10025-1	a)

Remarks: a) Tests are required when the properties are not stated in the mill certificates, or in any case of doubt. a)

- For stainless steel materials, the chemical composition test is required.
- Acceptance criteria
  - Should the test results not comply with the standard, two further test pieces shall be made on samples taken from the product from which the original test piece was prepared. If any one of additional test fails, the batch is considered not to comply with the standard.

3.3 Reception of Bolts, Nuts and Washers

- Samples of bolts, nuts and washers (minimum 3 test specimens per each sample) shall be collected in the sampling rate as tabulated in Table 2, to perform tensile test according to ISO 898. For Stainless steel bolt products, chemical analysis should be carried out (according to ISO 3506). Relate verification test should be performed when such properties are specified by design unit to be verified.

Table 2 Sampling bolts

Diameter of Bolt	Sampling rate
$\phi \leqq$ M16	1／15000
M16 $< \phi \leqq$ M24	1／5000
$\phi >$ M24	1／2500

- Acceptance criteria
  - If any test fails to comply with requirements, two additional tests shall be done. If any one of additional test fails, the lot is considered not to comply with the standard.

3.4 Reception of Welds

- The welding inspector should hold a validity certificate which qualified in accordance with EN 473, or ISO 9712, or ASNT SNT-TC-1A, or equivalent standard.

- Sampling
  - For full penetration butt welds, NDT (Non-destructive testing) shall be carried out 100%.
  - For fillet welds and partial penetration butt welds, NDT shall be carried out for at least 10%.
  - For fillet weld with leg length < 4 mm or Butt weld with thickness of thinner part < 4 mm, 100% visual inspection only.
- Reception test – Visual Inspection
  - The visual inspection of welds shall be in accordance with BS5289、EN970、BS EN ISO17637.
  - The visual inspection shall be performed after completion of welding in an area and before any other NDT inspection is carried out.
- Reception test – NDT (Non-destructive testing)

- In general, ultrasonic testing or radiographic testing applies to butt welds and penetrant testing or magnetic particle inspection applies to fillet welds, see table 3. The use of NDT methods must comply with the relevant requirements of the relevant standards.

Table 3 NDT methods choice

Type of welds	NDT methods	Standard
Butt weld	Ultrasonic testing (UT)	BS3293、BS EN1714、BS EN ISO17640
	Radiographic testing (RT)	BS2600、BS2910、BS EN1435、BS EN ISO17636
Fillet weld	Magnetic particle inspection (MT)	BS6072、BS EN ISO9934-1、BS EN1290、BS EN ISO17638
	Penetrant testing (PT)	BS6443、BSEN571-1、BS EN ISO3452-1

The NDT test of welds also carries out in accordance with AWS D1.1.

- Hold time before final NDT

  Due to the risk of delayed cracking, a period of at least 16 hours is generally required before the final inspection is made of as-welded fabrications. This hold time should be reduced for thin materials whose yield strength is less than 500 N/mm2 or should be increased for materials of thickness greater than 50 mm or of yield strength over 500 N/mm2. The hold time should be reduced or increased according with EN 1090-2, clause 14.4.2.1.

➢ Acceptance criteria

- The acceptance criteria in accordance with BS 5135 table 18 for butt welds and table 19 for fillet welds, or BS EN 25817, or AWS D1.1. Unless otherwise specified or agreed by design unit, regardless of the frequency of sampling, the more stringent level of the above mentioned criteria should be used for the acceptance level.

3.5 Reception of Hot-Dip Galvanized Articles (Refer to ARP / DMC / 002 for details.)

➢ Sampling

- One thickness test shall be made per 20 tons of material, or per each delivery, whichever

is less.

- One test of uniformity of coating shall be made per 100 tons, or per delivery, whichever is less.

➢ Reference standard
- The reference standard is BS 729、ISO 1461 and ISO 2178.

➢ Acceptance Criteria
- The tests results shall conform to the coating thickness requirements in Table 2 of ISO 1461 or to the project requirement, whichever is greater.
- The uniformity results shall conform to BS 729.
- In case of non-compliance, two more tests should be done on the lot. The lot will be accepted if all tests pass and rejected if any one fails.

3.6 Reception of Paintings (Refer to ARP / DMC / 001 for details.)

➢ Sampling
- For structural steelwork, 1 dry film coating thickness test shall be made per each 20 tons of steel materials. Tests shall be made on representative locations.
- For other steel articles such as guardrail, pipeline etc, one thickness test shall be made per each 500m2 painted area. Tests shall be made on representative locations.

➢ Reference standard
- The reference standard is ISO 12944: Part 1~8, ISO 2808.

➢ Acceptance Criteria
- For paint on steel articles: The average of all point values recorded should equal or exceed the nominal thickness, and there should be no values less than 80 % of the nominal thickness.
- For paint on galvanized steel articles: The average of all point values recorded should equal or exceed the sum of the nominal thickness of zinc coating and nominal thickness of paint, and no single value should be less than the sum of the nominal value of zinc coating and 80 % of the nominal value of paint thickness. For galvanized steel in accordance with ISO 1461, the nominal value should be either taken from Table 2 or from the project specification, depending on whichever is greater.
- The non-conforming area shall be re-painted and re-tested.
- If any test fails to comply with requirements, two additional tests shall be done. If any one of additional test fails, the lot is considered not to comply with the standard.

Remark: Care shall be taken in the utilization of paint, to adjust the coating to the nominal dry film thickness and to avoid excessive thickness in any areas. It is recommended that the maximum dry film thickness shall not be 3 times greater than the nominal dry film thickness.

3.7 Reception of Anchor bolts

- Sampling, reference standard, and acceptance criteria, please refer to ARP/DEE/009 for details.

3.8 Reception of shear stud

- Sampling
  - Visual inspection not less than 5%, at least 2 specimens.
  - Bend testing not less than 1%, at least 2 specimens.
- Reference standard
  - The reference standard is AWS D1.1 or BS5100: Part 6.
- Acceptance criteria
  - Visual inspection

    The defects such as crack , lack of fusion, porosity, slag are not permit.
  - Bend test

    The stud weld shall not show any signs of cracking or lack of fusion. Satisfactory studs shall not be bent back again.
  - If the test results do not comply with requirement, additional twice as the number of failed test pieces shall test until the result is satisfactory.

3.9 Reception of final torque of set of High Strength Bolt

- The final torque test should be carried out within 48H after the final screwing completed 1H.
- Sampling

  Check 10% of the number of nodes, and should not be less than 10; each of the spotted nodes is checked by 10% of bolts, and should not be less than 2.
- Reference standard
  - The reference standard is GB 50205.
- Acceptance criteria
  - Torque test

    The deviation between the torque value and the construction torque value within 10% is

accepted.

- Turn-of-nut test
  The final twist angle deviation within 10 ° is accepted.

4. Steel structure quality control procedures and reception test summary table

- The quality control procedures of steel structure engineering are summary as Table 4 - Summary Table of Fabricating/Processing Steel Structure Engineering for your reference.
- The receptions of quality control of steel structure engineering are summary as Table 5 - Summary Table of Quality control- Reception test for your reference.

Table 4 - Summary Table of Fabricating/Processing Steel Structure Engineering

Item	Steel Structure Engineer		Submission requirement [Note 1, 2]			Requirement	Checking	Remark
			1st stage	2nd stage	3rd stage			
1	Shop-Drawing and Method statement		<2.1.1 & 2.1.2>			[Note 3i & 3ii]	Before Each process start	
2	Quality Control of Material (Included appearance, specification, dimension, storage and delivery)	Steel Material	<2.1.3>	[Note 4]	[Note 4]	[Note 3(i) & 3(ii) & 3(iii)]	All	
		Welding consumable	<2.1.3>	--	--	[Note 3(i) & 3(ii) & 3(iii)]	All	
		Bolt system	<2.1.3>	--	[Note 4]	[Note 3(i) & 3(ii) & 3(iii)]	All	
		Anchor Bolt	<2.1.3>	--	--	[Note 3(i) & 3(ii) & 3(iii)]	All	
		Coating	<2.1.8>	--	--	[Note 3(i) & 3(ii) & 3(iii)]	All	
3	Inspection and Test plan (ITP)		<2.1.9>	--	--	[Note 3i & 3ii]	Before process start	
4	Third party Laboratory		<2.1.10>	--	--	[Note 3(i) & 3(ii)]	Before process start	
5	Steel Structure components oversea/inland Fabricated factory	Steel structure factory	<2.1.6>	<2.2.2>	--	[Note 3(i) & 3(ii)]	Factory inspection should be arranged before Steel components produce. If need, additional random inspection can be arranged.	
		Galvanizing factory/ Coating Factory	<2.1.7 & 2.1.8>	<2.2.2>	--	[Note 3(i) & 3(ii)]	Factory inspection should be arranged before Steel components produce. If need, additional random inspection can be arranged.	

[Note]:
1.1st Stage: submission; 2nd Stage: Steel components arrived on site; 3rd Stage: On site erection and each process reception.
2. Please see item <X.X.X> on this ARP.
3. (i). Macau Code of Steel Structure for Buildings (REAE); (ii). Project's technical specifications / contract rules; (iii). Requirement of Producer/Suppler/Fabricated Factory.
4. Reports for Reception test are issued by approved third party laboratory.

Table 4 - Summary Table of Fabricating/Processing Steel Structure Engineering

Item	Steel Structure Engineer		Submission requirement [Note 1, 2]			Requirement	Checking	Remark
			1st stage	2nd stage	3rd stage			
6	Delivery and storage for Steel Component		Method Statement	<2.2.1 to 2.2.3>	--	[Note 3(i) & 3(ii) & 3(iii)]	All	
7	Fabricated Steel Component/ On site erection	Welding process (included welder, WPS, WPQR etc)	<2.1.4 & 2.1.5> Method Statement	[Note 4]	[Note 4]	[Note 3(i) & 3(ii) & 3(iii)]	All	
		Bolt connection process	Method Statement	--	[Note 4]	[Note 3(i) & 3(ii) & 3(iii)]	All	
		Coating process (Included Galvanizing layer, each coating layer etc)	Method Statement	[Note 4]	[Note 4]	[Note 3(i) & 3(ii) & 3(iii)]; ARP/DMC/001 & 002	All	
		Shear Stud process	Method Statement	[Note 4]	[Note 4]	[Note 3(i) & 3(ii) & 3(iii)]	All	
		Anchor Bolt installation process	Method Statement	--	[Note 4]	[Note 3(i) & 3(ii) & 3(iii)]	All	

[Note]:
1.1st Stage: submission; 2nd Stage: Steel components arrived on site; 3rd Stage: On site erection and each process reception.
2. Please see item <X.X.X> on this ARP.
3. (i). Macau Code of Steel Structure for Buildings (REAE); (ii). Project's technical specifications / contract rules; (iii). Requirement of Producer/Suppler/Fabricated Factory.
4. Reports for Reception test are issued by approved third party laboratory.

Table 5 - Summary Table of Quality control- Reception test

	Reception test item [Note1, 2]	Frequency/ Standard/ Acceptance rule [Note1, 2]	Fabricated factory	On site [Note3]	Suggestion for sampling/ testing time [Note3]	Remark
Quality of Raw Material	Reception of Steel	<3.1 & 3.2>	✔	✔	After Material arrival, before fabricate.	
	Reception of Stainless Steel	<3.1 & 3.2>; ARP/DMC/12	✔	✔	After Material arrival, before fabricate.	
	Reception of Bolts, Nuts and Washer	<3.1 & 3.3>	✔	✔	After Material arrival, before use.	
Quality of Protection against corrosion/Coating	Reception of Galvanizing	<3.1 & 3.5> ARP/DMC/002	✔	✔	After Completed Galvanizing layer, before delivery/ use.	
	Reception of Coating	<3.1 & 3.6> ARP/DMC/001	✔	✔	Test will be carried out on the each completed coating layer. Steel components will be delivered, before passed all coating test.	
Quality of fabrication and erection of steel components	Reception of Weld Connection	<3.1 & 3.4>	✔	✔	After Completed weld joint, Before delivery/ Coating.	
	Reception of Shear Stud	<3.1 & 3.8>	✔	✔	After Completed installation, Before delivery/ cover layer	
	Reception of Anchor Bolt	<3.1 & 3.7> ARP/DEE/009	--	✔	After Completed installation, before the test should not install any accessories (such as steel plate, components etc) on the anchor bolt.	
	Reception of Final Torque of Set of High strength Bolt	<3.1 & 3.9>	--	✔	After completed installation, before coating.	

[Note]:
1. Please see item <X.X.X> on this ARP.
2. Reception test should be carried out the approved third party laboratory.
3. Subsequent work will be continued, after passed the test.

Reference standard

1. 第 29/2001 號行政法規 建築鋼結構規章 Regulamento de Estruturas de Aço para Edifícios (REAE)
2. ARP/DMC/01 Paint for Iron and Steel Work 铁器及钢制品塗漆
3. ARP/DMC/02 Hot-dip Galvanized Articles 熱浸鍍鋅製品
4. ARP/DMC/12 Stainless Steel Materials 不鏽鋼材
5. ARP/DEE/009 Anchor Bolt 錨固螺栓
6. EN 10002 Metallic materials-Tensile testing
7. BS EN ISO 6892 Metallic materials. Tensile testing. Method of test at room temperature
8. BS EN 10045 Charpy impact test on metallic materials.
9. BS EN ISO 148-1 Metallic materials. Charpy pendulum impact test. Test method
10. ISO 898-1 Mechanical properties of fasteners made of carbon steel and alloy steel. Bolts, screws and studs with specified property classes. Coarse thread and fine pitch thread
11. ISO 898-2 Mechanical properties of fasteners made of carbon steel and alloy steel. Nuts with specified property classes. Coarse thread and fine pitch thread
12. BS 5289 Code of practice. Visual inspection of fusion welded joints
13. BS EN 970 Non-destructive examination of fusion welds. Visual examination.
14. BS EN ISO 17637 Non-destructive testing of welds. Visual testing of fusion-welded joints
15. BS 2600 Radiographic examination of fusion welded butt joints in steel.
16. EN 1435 Non-destructive examination of welds. Radiographic examination of welded joints
17. BS 2910 Methods for radiographic examination of fusion welded circumferential butt joints in steel pipes
18. BS EN ISO 17636 Non-destructive testing of welds. Radiographic testing. X- and gamma-ray techniques with film
19. BS 3923 Methods for ultrasonic examination of welds.
20. EN 1714 Non destructive testing of welded joints. Ultrasonic testing of welded joints
21. BS 6072 Method for magnetic particle flaw detection
22. BS EN 1290:1998 Non-destructive examination of welds. Magnetic particle examination of welds
23. BS EN ISO 9934 Non-destructive testing. Magnetic particle testing.
24. BS EN ISO 17638 Non-destructive testing of welds. Magnetic particle testing
25. BS 6443 Method for penetrant flaw detection
26. BS EN 571 Non-destructive testing. Penetrant testing.
27. BS EN ISO 3452 Non-destructive testing. Penetrant testing.
28. ISO 14555 Welding. Arc stud welding of metallic materials
29. BS 5135 Specification for arc welding of carbon and carbon manganese steels
30. ISO 5817 Arc-welded joints in steel. Guidance on quality levels for imperfections
31. AWS D1.1 Structural Welding - Steel
32. ISO 2808 Paints and varnishes -- Determination of film thickness
33. ISO 2178 Non-magnetic coatings on magnetic substrates -- Measurement of coating thickness -- Magnetic method
34. BS 729 Specification for hot dip galvanized coatings on iron and steel articles

35. BS 5080 Structural fixings in concrete and masonry.
36. ISO 3506 Mechanical properties of corrosion-resistant stainless steel fasteners.
37. BS EN 287-1 Qualification test of welders. Fusion welding. Steels
38. BS EN 1418 Welding personnel. Approval testing of welding operators for fusion welding and resistance weld setters for fully mechanized and automatic welding of metallic materials
39. BS EN ISO 15614-1 Specification and qualification of welding procedures for metallic materials. Welding procedure test. Arc and gas welding of steels and arc welding of nickel and nickel alloys
40. BS EN ISO 15609 Specification and qualification of welding procedures for metallic materials. Welding procedure specification.
41. BS EN ISO 12944 Paints and varnishes. Corrosion protection of steel structures by protective paint systems.
42. ISO 8501 Preparation of steel substrates before application of paints and related products.
43. ISO 1461 Hot dip galvanized coatings on fabricated iron and steel articles.
44. BS EN 10025 Hot rolled products of structural steels.
45. EN 473 Non-destructive testing. Qualification and certification of NDT personnel.
46. ISO 9712 Non-destructive testing. Qualification and certification of NDT personnel
47. ASNT SNT-TC-1A Personnel Qualification and Certification in Nondestructive Testing provides guidelines for employers to establish in-house certification programs for the qualification and certification of nondestructive testing personnel.
48. GB 50205 Code for acceptance of construction quality of steel structures 鋼結構工程施工質量驗收規範

5. Contents