STRUCTURAL STEEL INSPECTOR'S WORKBOOK

Robert E. Shaw, Jr., PE

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Structural Steel Inspector's Workbook
2014 Edition

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INTRODUCTION

The Structural Steel Inspector's Workbook, 2014 edition, is written by Bob Shaw of the SSTC and published jointly by the SSTC and the International Code Council. This workbook can be used as a training tool or study guide for structural steel building inspectors, especially for those preparing to take the S1 and/or S2 Special Inspector certification examinations. It may also be used as test material to evaluate the knowledge and skills of structural steel inspectors. The Workbook contains key points for each section, multiple-choice questions, and an answer key at the back with the specific code provision citation. Approximately 400 questions are prepared for study and evaluation.

This workbook provides practical exercises to learn about various codes and standards governing steel building construction. It is suitable for either individual or classroom study. This independent-study format provides a method for the individual to complete the course at his or her own pace. The material is a compilation of multiple-choice questions pertaining to various codes, with an answer key providing specification and section number references. This workbook is not intended to cover the topics of light-gauge metal framing or plan reading.

Progressing through the course, the learner can measure his or her level of knowledge by using the quizzes provided in each study session. The quizzes are designed to help develop the habit of carefully reading specific material in the codes. The questions are not intended to be tricky or misleading; and the individual is not expected to be able to answer all questions without reference to the applicable standard or code.

The answer keys are based upon the codes and specifications governing steel building construction. The question numbers and correct answers are provided, with the code section number given as a reference. In many cases, other pertinent sections of the code should also be studied to gain a full understanding of the solution.

Although participants are encouraged to attain ICC certification for Special Inspection in Structural Bolting (S1) and Structural Welding (S2), this workbook is not intended to provide specific assistance in preparing for an ICC certification examination or to anticipate examination questions.

Questions or comments regarding the content or quizzes in this workbook are welcome. Please contact: Steel Structures Technology Center, Inc., 5277 Leelanau Ct, Howell, MI 48843-5437, info@steelstructures.com.

ABOUT INTERNATIONAL CODE COUNCIL®

The International Code Council is a member-focused association. It is dedicated to developing model codes and standards used in the design, build and compliance process to construct safe, sustainable, affordable and resilient structures. Most U.S. communities and many global markets choose the International Codes. ICC Evaluation Service (ICC-ES) is the industry leader in performing technical evaluations for code compliance fostering safe and sustainable design and construction.

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ABOUT STEEL STRUCTURES TECHNOLOGY CENTER

The Steel Structures Technology Center is focused on providing consulting services, technical resources and training related to the design, fabrication, erection, inspection and quality of steel-framed structures. Founded in 1990, SSTC has provided training and support to thousands of engineers, fabricators, erectors, inspectors, building officials and others involved in steel buildings, steel bridges and other forms of steel construction.

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WORKBOOK REFERENCES

This workbook references the following industry codes and standards governing steel building construction.

Workbook References	Year of Publication	Used in Chapters
International Code Council®		
International Building Code®	2015 2012 2009	1 - 3 21
Model Program for Special Inspection	2012	2
Special Inspection Manual	2012	3
American Institute of Steel Construction		
Steel Construction Manual, 14th Edition	2011	5 - 9 18
AISC 360-10 Specification for Structural Steel Buildings (in AISC 14th Edition Manual)	2010	5 - 9
AISC 303-10 Code of Standard Practice (in AISC 14th Edition Manual)	2010	6 - 7
AISC 341-10 Seismic Provisions for Structural Steel Buildings	2010	21
AISC 358s2-14 Prequalified Connections for Special and Intermediate Steel Moment Frames for Seismic Applications	2014	21
Research Council on Structural Connections		
Specification for Structural Joints Using High-Strength Bolts (in AISC 14th Edition Manual)	2009	8 - 9
American Welding Society		
AWS D1.1 Structural Welding Code - Steel	2010 2008	10 - 15
AWS D1.3 Structural Welding Code - Sheet Steel	2008	16
AWS D1.4 Structural Welding Code - Reinforcing Steel	2011 2005	17
AWS D1.8 Structural Welding Code - Seismic Supplement	2009	21
AWS A2.4 Standard Symbols for Welding, Brazing and Nondestructive Testing	2012 2007	18

Steel Joist Institute		
Standard Specifications and Load and Weight Tables for Steel Joists and Joist Girders, 43rd Edition, including: • SJI-K-2010, Standard Specifications for Open Web Steel Joists, K Series • SJI-LH/DLH-2010, Standard Specifications for Longspan Steel Joists, LH-Series and Deep Longspan Steel Joists, DLH-Series • SJI-JG-2010, Standard Specifications for Joist Girders • SJI-CJ-2010, Standard Specifications for Composite Steel Joists, CJ-Series • SJI-COSP-2010, Code of Standard Practice for Steel Joists and Joists Girders • SJI-CJCOSP-2010, Code of Standard Practice for Composite Steel Joists	2010	19
Steel Deck Institute		
ANSI/SDI QA/QC-2011, Standard for Quality Control and Quality Assurance for Installation of Steel Deck	2011	20
ANSI/SDI C-2011 Standard for Composite Steel Floor Deck - Slabs	2011	20
ANSI/SDI NC-2010, Standard for Non-Composite Steel Floor Deck	2010	20
ANSI/SDI RD-2010, Standard for Steel Roof Deck	2010	20
COSP14, SDI Code of Standard Practice 2014	2014	20

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STUDY GUIDE	CHAPTER 1 INTERNATIONAL BUILDING CODE®

OBJECTIVE

To become familiar with the Special Inspection, Structural Observation and steel inspection provisions of the International Building Code.

REFERENCES

International Building Code, 2009

- Chapter 1 - Administration
  - 107 Submittal Documents
  - 110 Inspections
- Chapter 17 – Structural Tests and Special Inspections
  - 1701 General
  - 1702 Definitions
  - 1703 Approvals
  - 1704 Special Inspections (1704.1 through 1704.3)
  - 1705 Statement of Special Inspections
  - 1706 Special Inspections for Wind Requirements
  - 1707 Special Inspections for Seismic Resistance
  - 1708 Structural Testing for Seismic Resistance
  - 1709 Contractor Responsibility
  - 1710 Structural Observations
- Chapter 22 – Steel
  - 2201 General
  - 2202 Definitions
  - 2203 Identification and Protection of Steel for Structural Purposes
  - 2204 Connections
  - 2205 Structural Steel
  - 2206 Steel Joists

International Building Code, 2012

- Chapter 1 - Administration
  - 107 Submittal Documents
  - 110 Inspections
- Chapter 2 - Definitions
  - 202 Definitions
- Chapter 17 - Special Inspections and Tests
  - 1701 General
  - 1702 Definitions
  - 1703 Approvals
  - 1704 Special Inspections, Contractor Responsibility and Structural Observations
  - 1705 Required Verification and Inspection (1705.1 through 1705.2)
- Chapter 22 - Steel
  - 2201 General
  - 2202 Definitions
  - 2203 Identification and Protection of Steel for Structural Purposes
  - 2204 Connections
  - 2205 Structural Steel
  - 2206 Composite Structural Steel and Concrete Structures
  - 2207 Steel Joists

International Building Code, 2015

- Chapter 1 - Administration
  - 107 Submittal Documents
  - 110 Inspections
- Chapter 2 - Definitions
  - 202 Definitions
- Chapter 17 - Special Inspections and Tests
  - 1701 General
  - 1702 Definitions
  - 1703 Approvals
  - 1704 Special Inspections and Tests, Contractor Responsibility and Structural Observations
  - 1705 Required Verification and Inspection (1705.1 through 1705.2)
- Chapter 22 - Steel
  - 2201 General
  - 2202 Definitions
  - 2203 Identification and Protection of Steel for Structural Purposes
  - 2204 Connections
  - 2205 Structural Steel
  - 2206 Composite Structural Steel and Concrete Structures
  - 2207 Steel Joists

KEY POINTS

International Building Code

Chapter 1

- What information regarding Special Inspection is submitted to secure a building permit?
- Who is the Registered Design Professional in Responsible Charge?
- What are the responsibilities of the Registered Design Professional in Responsible Charge?
- What inspections are required?

Chapter 2 (also see Chapter 17 in earlier editions of the International Building Code)

- What is continuous Special Inspection? Periodic Special Inspection?
- Who is an approved agency?
- What is a fabricated item?
- Who is an approved Fabricator?
- What is a certificate of compliance?
- What is Structural Observation?

Chapter 17

- What is necessary to be an approved agency?
- Who employs the Special Inspector?
- Who may be a Special Inspector?
- When may Special Inspection be waived?
- What information regarding Special Inspection is required for a building permit?
- What reporting is expected of a Special Inspector?
- What is required to become an approved Fabricator?
- What must the Fabricator do when Special Inspection is waived?
- What are the duties of a Special Inspector of steel construction?
- What are the duties of an Inspector of high-strength bolting?
- What information must be included in the Statement of Special Inspections?
- When is Structural Observation required?

Chapter 22 - Steel

- What are the material identification requirements for structural steel?
- What specifications govern structural steel construction?
- What specifications govern steel joist construction?
- How high must an anchor bolt protrude above the base plate?

QUIZ	CHAPTER 1 INTERNATIONAL BUILDING CODE®

1.1 Provisions for a Special Inspection program shall be submitted to the Building Official:

- □ a. prior to issuance of a building permit
- □ b. before foundations are begun
- □ c. before fabrication is begun
- □ d. before erection is begun

1.2 The statement of Special Inspections must include:

- □ a. the list of the materials and the work requiring Special Inspection
- □ b. identification of each inspection as continuous, periodic, (or other)
- □ c. the inspections to be performed
- □ d. all of the above

1.3 Periodic Special Inspection is:

- □ a. part-time or intermittent observation of the work (intermittently present where the work to be inspected has been or is being performed)
- □ b. not permitted
- □ c. not required until after the structural steel is completed
- □ d. to be done no less often than on a weekly basis

1.4 Continuous Special Inspection means:

- □ a. the Inspector observes the work on a regular basis
- □ b. the Inspector is on site observing the work requiring Special Inspection (present when and where the work to be inspected is being performed
- □ c. the Inspector carefully inspects the completed work
- □ d. the Inspector never leaves the work site while workers are present

1.5 The Special Inspector is be employed by:

- □ a. the Owner
- □ b. the Registered Design Professional in Responsible Charge acting as the Owner's agent
- □ c. the Contractor or person responsible for the work
- □ d. either "a" or "b"

1.6 The Special Inspector must be qualified and demonstrate competence to the satisfaction of:

- □ a. the Contractor
- □ b. the Registered Design Professional in Responsible Charge
- □ c. the Building Official
- □ d. all of the above

1.7 Special Inspections may be waived by the Building Official if:

- □ a. the building is already being completed
- □ b. fewer than 10 people will occupy the structure
- □ c. construction is of a minor nature
- □ d. the cost of the project is less than $100,000

1.8 A fabricated item is:

- □ a. structural, load-bearing assemblies of materials assembled prior to installation in the building
- □ b. a steel member subjected to punched or drilled holes, or cambered using mechanical means
- □ c. rolled steel shapes as produced by the steel mill
- □ d. either "a" or "b"

1.9 To be an approved agency:

- □ a. it must be independent, and disclose possible conflicts of interest
- □ b. it must have adequate equipment to perform the required tests
- □ c. it must have personnel educated and experienced in conducting the required inspections and tests
- □ d. all of the above

1.10 The Special Inspector is to:

- □ a. submit reports to the Building Official and the Registered Design Professional in Responsible Charge
- □ b. report discrepancies in construction from the approved construction documents to the Contractor
- □ c. bring uncorrected discrepancies to the attention of the Building Official and the Registered Design Professional in Responsible Charge
- □ d. all of the above

1.11 To become an approved Fabricator, the Fabricator must have:

- □ a. a written fabrication procedural manual and quality control manual
- □ b. a review of their written procedural and quality control manuals by an approved agency
- □ c. periodic auditing of their plant's practices by an approved agency
- □ d. all of the above

1.12 Special Inspection of work performed at a Fabricator's shop is waived provided:

- □ a. the Fabricator is registered and approved by the Building Official to do the work without Special Inspection
- □ b. the Fabricator submits a certificate of compliance upon completion of the work
- □ c. both "a" and "b"
- □ d. either "a" or "b"

1.13 If no welding, cutting or heating is performed as a part of steel fabrication:

- □ a. continuous Special Inspection is required
- □ b. no Special Inspection of fabrication is required, but the Fabricator must submit and implement a procedure for material control
- □ c. periodic Special Inspection is permitted
- □ d. nothing is required

1.14 The tops of anchor bolts must be:

- □ a. at least two threads above the top of the nut
- □ b. at least flush with the top of the nut
- □ c. at least one-half into the height of the nut
- □ d. at least 3 inches above the top of the base plate

NOTE: The following questions are based upon the 2009 edition of the IBC. Provisions directly addressing these topics for structural steel were removed effective with the 2012 edition of the IBC, which references AISC 360-10.

1.15 Except for certain types and sizes of welds, inspection of structural welding is to be done:

- □ a. during the welding operations
- □ b. after the shop welds are completed, but before erection
- □ c. after field erection is complete
- □ d. when called by the welder or welding Contractor

1.16 Welds eligible for periodic inspection include:

- □ a. floor and roof deck welds
- □ b. single pass fillet welds $^{5}/_{16}$ inch and less in size
- □ c. welded shear connectors for structural diaphragms
- □ d. all of the above

1.17 Welding of stairs and railing systems:

- □ a. requires continuous inspection
- □ b. may be inspected on a periodic basis
- □ c. need not be inspected
- □ d. must be done in an approved Fabricator's shop

1.18 The Special Inspector shall perform an inspection of the steel frame to verify proper construction of:

- □ a. bracing
- □ b. stiffening
- □ c. joint details
- □ d. all of the above

1.19 For bolted connections, the Special Inspector must check:

- □ a. the materials (bolts, nuts, washers, paint)
- □ b. the connected parts (holes, faying surfaces)
- □ c. the installation and tightening procedures
- □ d. all of the above

1.20 For pretensioned bolted joints, the Special Inspector must:

- □ a. determine that all plies of connected materials have been drawn together and properly snugged
- □ b. monitor the installation of the bolts to verify that the selected procedure is being properly used to tighten the bolts
- □ c. perform torque testing of 10% of the bolts, minimum two per connection
- □ d. both "a" and "b"

1.21 Periodic monitoring of bolt installation for pretensioned bolts is permitted:

- □ a. if the match-marked turn-of-nut method is used
- □ b. if the twist-off bolt method is used
- □ c. if the direct tension indicator method is used
- □ d. any of the above

1.22 Continuous monitoring of bolt installation of pretensioned joints is required:

- □ a. if the turn-of-nut method is used without match-marking
- □ b. if the calibrated wrench method is used
- □ c. when torque testing of 10% of the bolts, minimum two per connection, will not be performed
- □ d. either "a" or "b"

1.23 Special Inspections for seismic resistance of structural steel shall be in accordance with:

- □ a. the quality control provisions of AISC 341
- □ b. the quality assurance provisions of AISC 341
- □ c. both "a" and "b"
- □ d. either "a" or "b"

NOTE: The following questions are based upon the 2012 and 2015 editions of the IBC.

1.24 Special Inspection of structural steel shall be in accordance with:

- □ a. the quality control provisions of AISC 360
- □ b. the quality assurance provisions of AISC 360
- □ c. both "a" and "b"
- □ d. either "a" or "b"

1.25 Special Inspection for seismic resistance of structural steel shall be in accordance with:

- □ a. the quality control provisions of AISC 341
- □ b. the quality assurance provisions of AISC 341
- □ c. both "a" and "b"
- □ d. either "a" or "b"

ANSWER KEY	CHAPTER 1 INTERNATIONAL BUILDING CODE®

REFERENCES

International Building Code, 2009

International Building Code, 2012

International Building Code, 2015

		IBC, 2009	IBC, 2012	IBC, 2015
1.1	a	107.1; 1704.1.1; 1705.1	107.1; 17.4.2; 1704.3	107.1; 1704.2; 1704.3
1.2	d	1705.2	1704.3.1	1704.3.1
1.3	a	1702	202	202
1.4	b	1702	202	202
1.5	d	1704.1	1704.2	1704.2
1.6	c	1704.1	1704.2.1	1704.2.1
1.7	c	1704.1, Exception 1	1704.2, Exception 1	1704.2, Exception 1
1.8	a	1702	202	202
1.9	d	1703.1	1703.1	1703.1
1.10	d	1704.1.2	1704.2.4	1704.2.4
1.11	d	1704.2.2	1704.2.5.2	1704.2.5.1
1.12	c	1704.2.1, Exception; 1704.2.2	1704.2.5.1, Exception; 1704.2.5.2	1704.2.5, Exceptions; 1704.2.5.1
1.13	b	1704.3, Exception 1	1705.2, Exception	1705.2, Exception
1.14	b	2204.2.1	2204.2.1	2204.3
1.15	a	1704.3, Exception 2; Table 1704.3, Item 5a	---	---
1.16	d	1704.3, Exception 2	---	---
1.17	b	1704.3, Exception 2.5	---	---
1.18	d	1704.3.2; Table 1704.3, Item 6	---	---
1.19	d	1704.3.3.1	---	---
1.20	d	1704.3.3.1	---	---
1.21	d	1704.3.3.2	---	---
1.22	d	1704.3.3.3	---	---
1.23	b	1707.2	---	
1.24	b	---	1705.2.1	1705.2.1
1.25	b	---	1705.11.1	1705.12.1

STUDY GUIDE	CHAPTER 2 MODEL PROGRAM FOR SPECIAL INSPECTION

OBJECTIVE

To become familiar with the Special Inspection recommendations of the Model Program for Special Inspection.

REFERENCE

Model Program for Special Inspection, 2012

KEY POINTS

Model Program for Special Inspection, 2012

- What is the purpose of Special Inspection?
- What are the duties and responsibilities of the Special Inspector?
- What information should be included in the Special Inspector's reports?
- What are the duties and responsibilities of the Design Professional in Responsible Charge?
- What are the duties and responsibilities of the Contractor?
- What are the duties and responsibilities of the Building Official?
- What Special Inspector qualifications are recommended for code knowledge? For experience?
- What is included in a typical Statement of Special Inspections Agreement?
- What is included in a typical Statement of Special Inspections Schedule for Steel Construction?
- What are typical job tasks for Structural Steel and Bolting Special Inspectors regarding material sampling, testing and verification? High strength bolting? Steel framing observation?
- What are typical job tasks for Structural Welding Special Inspectors regarding material sampling, testing and verification? Structural steel welding? Reinforcing steel welding? Sheet steel welding?

QUIZ	CHAPTER 2 MODEL PROGRAM FOR SPECIAL INSPECTION

2.1 The purpose of Special Inspection is to:

- □ a. monitor materials and workmanship critical to the integrity of the building structure
- □ b. review work of the Contractors to ensure approved plans and specifications are being followed
- □ c. ensure relevant codes and ordinances are being observed
- □ d. all of the above

2.2 Special Inspectors should:

- □ a. try to arrive at the jobsite and observe the work without being noticed by the Contractor personnel
- □ b. notify Contractor personnel of their presence and responsibilities at the jobsite
- □ c. observe the work only after hours so as not to impede Contractor's production
- □ d. observe activities from offsite, so as not to be noticed

2.3 A nonconforming item should be:

- □ a. immediately written up as a report, with copies to the Building Official and Registered Design Professional in Responsible Charge
- □ b. immediately brought to the attention of the Contractor, and written up as a report if not corrected
- □ c. immediately written up in a report, but the report is not turned in to the Building Official unless it is not corrected
- □ d. immediately written up as a report, and the report given to the Contractor

2.4 A nonconformance report should include, as a minimum:

- □ a. a description and the exact location of the nonconformance
- □ b. a reference to the applicable detail in the approved plans/specifications
- □ c. the name and title of each individual notified, and the method of notification
- □ d. all of the above

2.5 The Special Inspection Report should:

- □ a. be completed and submitted daily to the Building Official
- □ b. be completed daily, and submitted weekly, to the Building Official
- □ c. be completed for each inspection visit, and submitted on a timely basis as determined by the Building Official
- □ d. be completed weekly, and submitted at the end of the job

2.6 The Special Inspection Report should:

- □ a. describe inspections and tests made, their locations, and whether the Contractor's work met the requirements
- □ b. list nonconforming items and their resolution, if any
- □ c. list changes authorized by the Registered Design Professional, if not included in a list of nonconforming items
- □ d. all of the above

2.7 The Contractor is to provide the Special Inspector:

- □ a. notice at least 24 hours before the start of the work
- □ b. notice at least 72 hours before the start of the work
- □ c. adequate notice to enable the Special Inspector to become familiar with the project
- □ d. notice of at least one day per 300 miles of the Special Inspector's travel distance to the plant or jobsite

2.8 The following parties are authorized to issue a stop work order:

- □ a. Special Inspector
- □ b. Building Official
- □ c. Registered Design Professional in Responsible Charge
- □ d. any or all of the above

2.9 The Building Official may require proof of experience for the Special Inspector in the following forms:

- □ a. written references verifying the individual's related work experience
- □ b. a personal interview to evaluate the individual's work experience and suitability to be a Special Inspector
- □ c. evidence of compliance with a recognized industry experience guideline
- □ d. any or all of the above

2.10 The final report from the Special Inspector should state:

- □ a. whether the work was in compliance with the approved plans and applicable provisions of the IBC
- □ b. dates when inspections were conducted
- □ c. names of all craftspeople whose work was inspected
- □ d. copies of all material certifications

2.11 If material sampling is required, the Special Inspector is responsible for:

- □ a. witnessing the preparation of test samples
- □ b. providing or arranging for documentation and transportation of the samples to the laboratory
- □ c. verifying that the testing is performed as required by the applicable standards and specifications
- □ d. all of the above

2.12 Which of the following is <u>not</u> an inspection task for a Special Inspector of Structural Steel and Bolting?

- □ a. verify protected storage of bolts, nuts and washers
- □ b. verify compliance of faying surfaces at connections
- □ c. conduct bolt tension verification tests
- □ d. verify use of approved method and sequence of tightening

2.13 Which of the following is <u>not</u> an inspection task for a Special Inspector of Structural Steel and Bolting?

- □ a. verify structural steel frame orientation, details and frame member sizes
- □ b. verify grout placement and sampling
- □ c. verify that base plates are securely seated and fastened
- □ d. verify plumbness of columns and levelness of floors

2.14 Which of the following is <u>not</u> an inspection task for a Special Inspector of Structural Welding?

- □ a. conduct qualification testing of welders before welding begins
- □ b. verify that the steel shapes, base metals, filler metals and gases are of the type, size, grade and condition specified
- □ c. provide or arrange for the documentation and transportation of samples to the laboratory
- □ d. verify that required nondestructive examinations are performed as required

2.15 Which of the following is <u>not</u> an inspection task for a Special Inspector of Structural Welding?

- □ a. verify welding equipment is capable of producing the specified welds
- □ b. verify qualifications of welding personnel for the work to be performed
- □ c. verify WPSs are either prequalified or have been properly qualified by test
- □ d. witness the welding of all CJP groove welds

2.16 Which of the following are inspection tasks for a Special Inspector of Structural Welding?

- □ a. verify that welds have the specified length and effective throat
- □ b. verify that the fabricated elements are within permissible tolerances
- □ c. verify that weldments have the proper joint geometry, and have backing and weld tabs where required
- □ d. all of the above

2.17 An individual not having the needed qualifications to do the work may perform Special Inspection under what conditions?

- □ a. the individual is working under the direct and continuous supervision of a Special Inspector fully qualified for the type of work involved
- □ b. the individual is working under the indirect or periodic supervision of a Special Inspector; and the scope of work is minor and/or routine and within the capabilities of the individual
- □ c. the individual is specifically approved to do the work by the Building Official
- □ d. any of the above

ANSWER KEY	CHAPTER 2 MODEL PROGRAM FOR SPECIAL INSPECTION

REFERENCE

Model Program for Special Inspection, 2012

		Model Program for Special Inspection, 2012
2.1	d	II. A. Purpose of Special Inspection
2.2	b	II. B. 2. Duties and Responsibilities of the Special Inspector
2.3	b	II. B. 4. Duties and Responsibilities of the Special Inspector
2.4	d	II. B. 4. Duties and Responsibilities of the Special Inspector
2.5	c	II. B. 5. Duties and Responsibilities of the Special Inspector
2.6	d	II. B. 5. Duties and Responsibilities of the Special Inspector
2.7	c	II. E. Duties and Responsibilities of the Contractor
2.8	b	II. F. Duties and Responsibilities of the Building Official
2.9	d	III. B. Experience Standards
2.10	a	Appendix B, D.1. General requirements
2.11	d	Appendix B, D.2. Material sampling, testing and verification
2.12	c	Appendix B, D.3. High-strength bolting
2.13	d	Appendix B, D.4. Steel framing observation
2.14	a	Appendix B, E.2. Material sampling, testing and verification
2.15	d	Appendix B, E.3. Structural, reinforcing and sheet steel welding
2.16	d	Appendix B, E.3. Structural, reinforcing and sheet steel welding
2.17	d	Appendix C, C. Special Inspector in Training

STUDY GUIDE	CHAPTER 3 SPECIAL INSPECTION MANUAL

OBJECTIVE

To become familiar with the Special Inspection recommendations of the Special Inspection Manual.

REFERENCE

Special Inspection Manual, 2012

KEY POINTS

Special Inspection Manual, 2012

- What are the duties and responsibilities of the Special Inspector prior to arrival on the jobsite? At the jobsite? At the end of the project?
- Who hires the Special Inspector?
- What tasks are involved with the inspection of Fabricators?
- What are the duties and responsibilities of the Registered Design Professional in Responsible Charge?
- What are the duties and responsibilities of the Contractor?
- What are the duties and responsibilities of the Building Official?
- How are jurisdictional inspection different than Special Inspection?
- What is the difference between periodic and continuous Special Inspection?
- What are the AISC 360 Quality Assurance (Special Inspection) requirements?
- How does AISC 360 prescribe welding inspection? Welding nondestructive testing? Bolting inspection?
- What are the AISC 341 Seismic Quality Assurance (Special Inspection) requirements?
- How does AISC 341 prescribe welding inspection? Welding nondestructive testing? Bolting inspection?
- What is Structural Observation?
- Who performs Structural Observation?
- For what types of structures and structural elements is Structural Observation required?
- What is included in a typical Statement of Special Inspections Agreement?
- What is included in a typical Statement of Special Inspections Schedule for Steel Construction?
- What Special Inspector qualifications are recommended for code knowledge? For experience?
- What are typical job tasks for Structural Steel and Bolting Special Inspectors regarding material sampling, testing and verification? High strength bolting? Steel framing observation?
- What are typical job tasks for Structural Welding Special Inspectors regarding material sampling, testing and verification? Structural steel welding? Reinforcing steel welding? Sheet steel welding?

Note: Subject matter such as "Job Task Lists" provided in the Model Program for Special Inspection, 2012 is included in the Special Inspection Manual, 2012. Users of this workbook are encouraged to also use Chapter 2 of this workbook, in addition to Chapter 3, for study of Special Inspection Manual material.

QUIZ	CHAPTER 3 SPECIAL INSPECTION MANUAL

3.1 Prior to visiting the jobsite for the first time, the Special Inspector should:

- □ a. review the Statement of Special Inspections and clarify any questions
- □ b. review approved plans and specifications
- □ c. review additional requirements from the jurisdiction for Special Inspection (if any)
- □ d. all of the above

3.2 In addition to the items listed in Question 3.1, the Special Inspector should:

- □ a. discuss frequency of progress reports with Building Official
- □ b. review the project schedule
- □ c. determine if Special Inspection of materials from a non-approved fabrication facility will be required
- □ d. all of the above

3.3 At the jobsite, the Special Inspector should:

- □ a. notify Contractor personnel of presence and responsibilities at the job site
- □ b. observe the assigned work
- □ c. perform or observe required testing
- □ d. all of the above

3.4 In addition to the items listed in Question 3.3, the Special Inspector should:

- □ a. report on nonconforming items immediately (any discrepancies)
- □ b. provide timely progress reports (on a daily or weekly basis as predetermined with Building Official)
- □ c. follow site requirements for safety
- □ d. all of the above

3.5 In reviewing the contents of the Statement of Special Inspections, the Special Inspector should:

- □ a. determine what inspections and tests are required
- □ b. determine the frequency of tests
- □ c. determine who conditions and transports the test specimens to the laboratory, if offsite testing is to be done by a third party
- □ d. all of the above

3.6 The intent of continuous Special Inspection is:

- □ a. have a Special Inspector on site during the entire process of the work being inspected
- □ b. have a Special Inspector available full-time on site
- □ c. have the Special Inspector observing all activities as they are conducted
- □ d. all of the above

3.7 What information should be included in the inspection record prepared by the Special Inspector?

- □ a. each location of inspection, type of inspection, and frequency of inspection
- □ b. nonconforming items (discrepancies)
- □ c. any changes, requests for information (RFI) or corrections to the construction process
- □ d. all of the above

3.8 At what point should the Special Inspector notify the Building Official and the Registered Design Professional in Responsible Charge of a nonconforming item?

- □ a. not resolved in a timely manner
- □ b. soon to be covered up without resolution
- □ c. either "a" or "b"
- □ d. end of the week

3.9 What should the Special Inspector include in a nonconformance report?

- □ a. description and exact location
- □ b. reference to the applicable detail of the approved plans and specification
- □ c. name and title of each individual notified and method of notification
- □ d. all of the above

3.10 The Special Inspector's final report should include:

- □ a. items not in conformance
- □ b. discrepancies in inspection coverage (for example, missed inspections)
- □ c. unresolved items
- □ d. all of the above

3.11 What form of natural disaster kills more Americans and destroys more property than any other?

- □ a. earthquake
- □ b. wind
- □ c. flood
- □ d. wildfires

3.12 What is the most common reason for loss from high wind?

- □ a. structures cannot be designed to resist hurricane force winds
- □ b. structures cannot be designed to resist tornado force winds
- □ c. inadequate attention to wind-critical details during design, construction and inspection
- □ d. all of the above

3.13 A seismic force resisting system is:

- □ a. system or section of a structural frame of a building specifically designed to resist the lateral (side to side) motion of an earthquake
- □ b. a nonstructural system that is designed to resist seismic forces
- □ c. both "a" and "b"
- □ d. neither "a" nor "b"

3.14 Braces and ties for lighting systems and sprinkler lines suspended from ceilings are examples of:

- □ a. seismic force resisting systems
- □ b. seismic load resisting systems
- □ c. designated seismic systems
- □ d. any of the above

3.15 The term used in AISC 360-10 that relates most closely to Special Inspection is:

- □ a. quality control
- □ b. quality assurance
- □ c. observe
- □ d. perform

3.16 Structural Observation is defined as:

- □ a. visual observation of the structural system by a Registered Design Professional (RDP) for the general conformance to the approved construction documents
- □ b. general verification by a Registered Design Professional (RDP) that critical elements of the structural system are being constructed as specified
- □ c. inspections performed by a Registered Design Professional (RDP) in addition to those performed by the Special Inspector
- □ d. inspections performed by a Registered Design Professional (RDP) in lieu of inspections to be performed by the Special Inspector

ANSWER KEY	CHAPTER 3 SPECIAL INSPECTION MANUAL

REFERENCE

Special Inspection Manual, 2012

		Page	Special Inspection Manual, 2012
3.1	d	11	Chapter 2 - Duties and Responsibilities of the Special Inspector
3.2	d	11	Chapter 2 - Duties and Responsibilities of the Special Inspector
3.3	d	12	Chapter 2 - Duties and Responsibilities of the Special Inspector
3.4	d	12	Chapter 2 - Duties and Responsibilities of the Special Inspector
3.5	d	12	Chapter 2 - Statement of Special Inspections
3.6	a	13	Chapter 2 - Periodic and Continuous Special Inspections
3.7	d	17	Chapter 2 - Progress Report
3.8	c	17	Chapter 2 - Nonconforming Items
3.9	d	17	Chapter 2 - Nonconforming Items
3.10	d	18	Chapter 2 - End of Project
3.11	b	49	Chapter 4 - Wind Resistance
3.12	c	49	Chapter 4 - Wind Resistance
3.13	a	50	Chapter 4 - Seismic Resistance
3.14	c	50	Chapter 4 - Seismic Resistance
3.15	b	59	Chapter 5 - AISC 360 Quality Assurance (Special Inspection) Requirements
3.16	a	119	Chapter 7 - Structural Observation

STUDY GUIDE	CHAPTER 4 TERMS AND DEFINITIONS

OBJECTIVE

To become familiar with the general terms used in steel construction, including specific terms for welding and bolting.

REFERENCES

AISC Steel Construction Manual, 14th Edition, 2011

AWS D1.1:2008 Structural Welding Code - Steel, 2008
AWS D1.1:2010 Structural Welding Code - Steel, 2010

Although not required for inspection purposes, the following texts provide additional general information and reference material that may be useful in performing inspection tasks:

AWS Welding Handbooks, published by American Welding Society
Structural Bolting Handbook, published by Steel Structures Technology Center
Structural Welding Quality Handbook, published by Steel Structures Technology Center
Other general textbooks on steel design or construction, as available

KEY POINTS

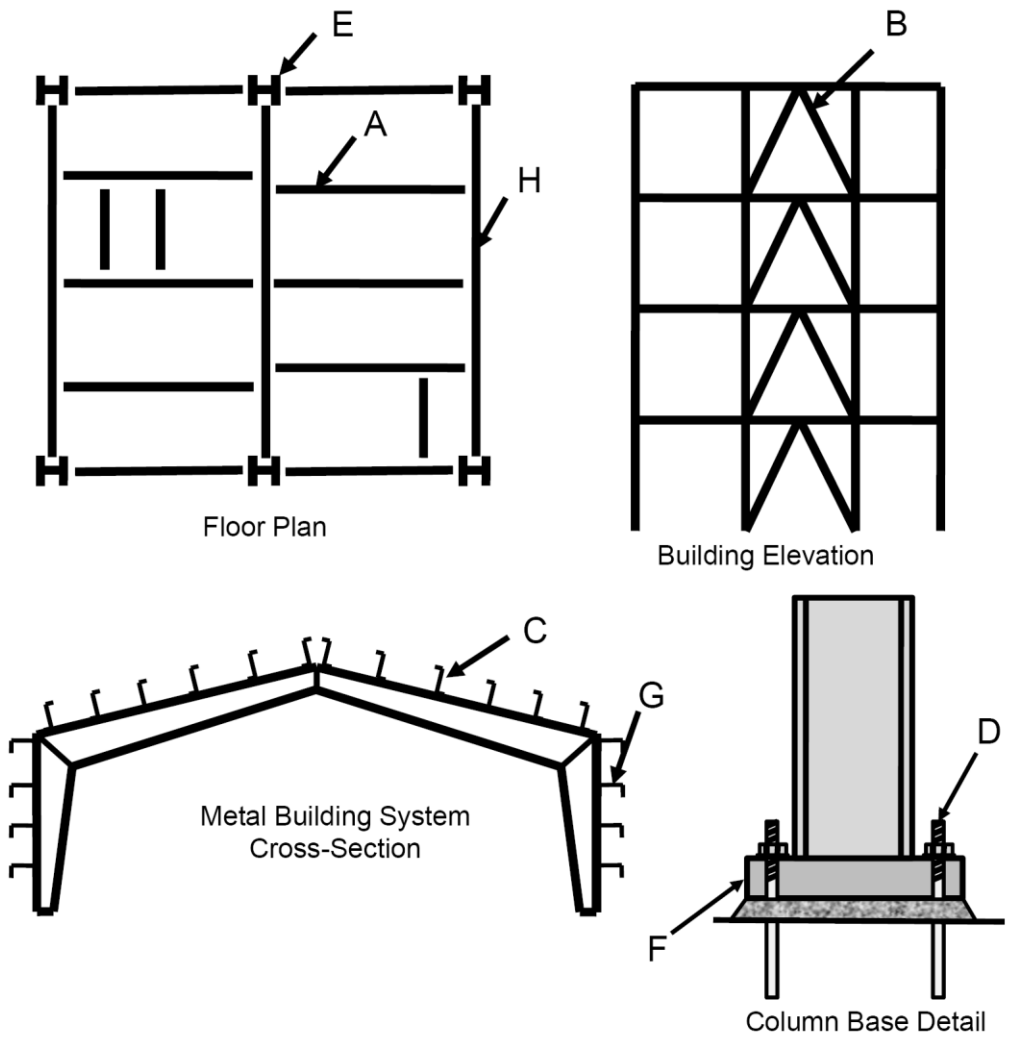
- Know the various components of a steel-framed building - column, beam, girder, purlin, girt, eave strut, brace, sag rod, etc.
- Know the various components of a truss - chord, web, gusset plate, stitch bar, panel point
- Know the various components of a bolted connection - bolt head, chamfer circle, washer face, shank, thread, thread runout, stickout, faying surface
- Know the various components of a welded joint - root, root opening, root face, groove face, groove angle, reinforcement, convexity, concavity, toe, depth of preparation, penetration, throat, leg, heat-affected zone, backing, weld tab, spacer
- Know the various types of welded joints - butt, tee, corner, lap, edge
- Know the various types of groove welds - square, bevel, V, J, U, flare-bevel, flare-V, single, double
- Know the various types of welding processes - SMAW, GMAW, GTAW, SAW, ESW, EGW, FCAW-S, FCAW-G

QUIZ	CHAPTER 4 TERMS AND DEFINITIONS

4.1 Identify each structural component shown in Figure 4-1 by its letter designation.

_____ column
_____ anchor bolts / anchor rods
_____ base plate
_____ beam
_____ girder
_____ bracing
_____ girt
_____ purlin

Figure 4-1



4.2 Identify each bolt or bolted joint component shown in Figure 4-2 by its letter designation.

_____ head
_____ diameter
_____ thread
_____ bolt length
_____ shank
_____ thread runout
_____ chamfer circle
_____ washer face
_____ manufacturer's mark
_____ nut face
_____ faying surface
_____ bolt stickout

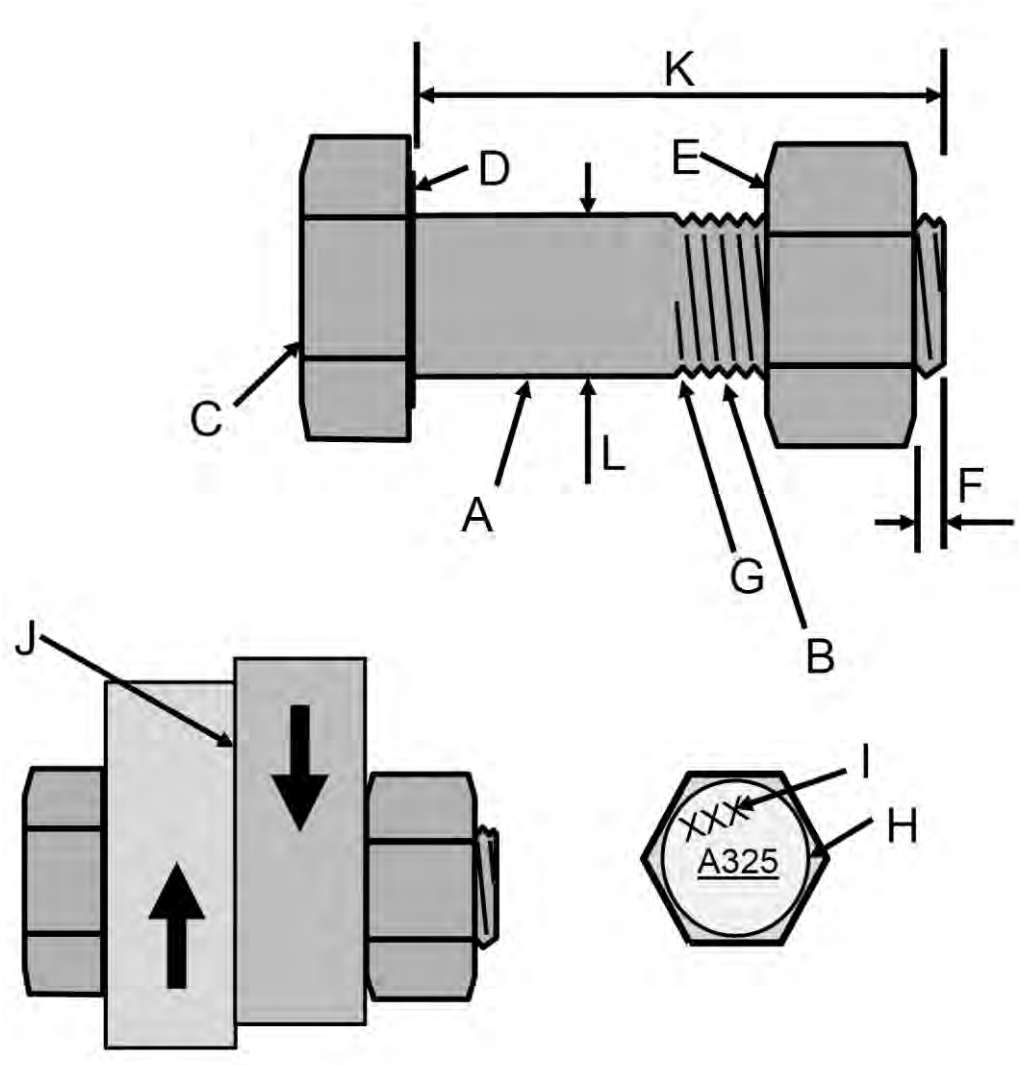


Figure 4-2

4.3 Identify each groove weld or welded joint component shown in Figure 4-3 by its letter designation.

_____ root
_____ root opening
_____ groove angle
_____ groove face
_____ groove radius / root radius
_____ groove face
_____ reinforcement
_____ depth of preparation
_____ penetration (depth of penetration)
_____ heat-affected zone
_____ backing
_____ weld tab (run-off tab, extension bar)
_____ spacer bar

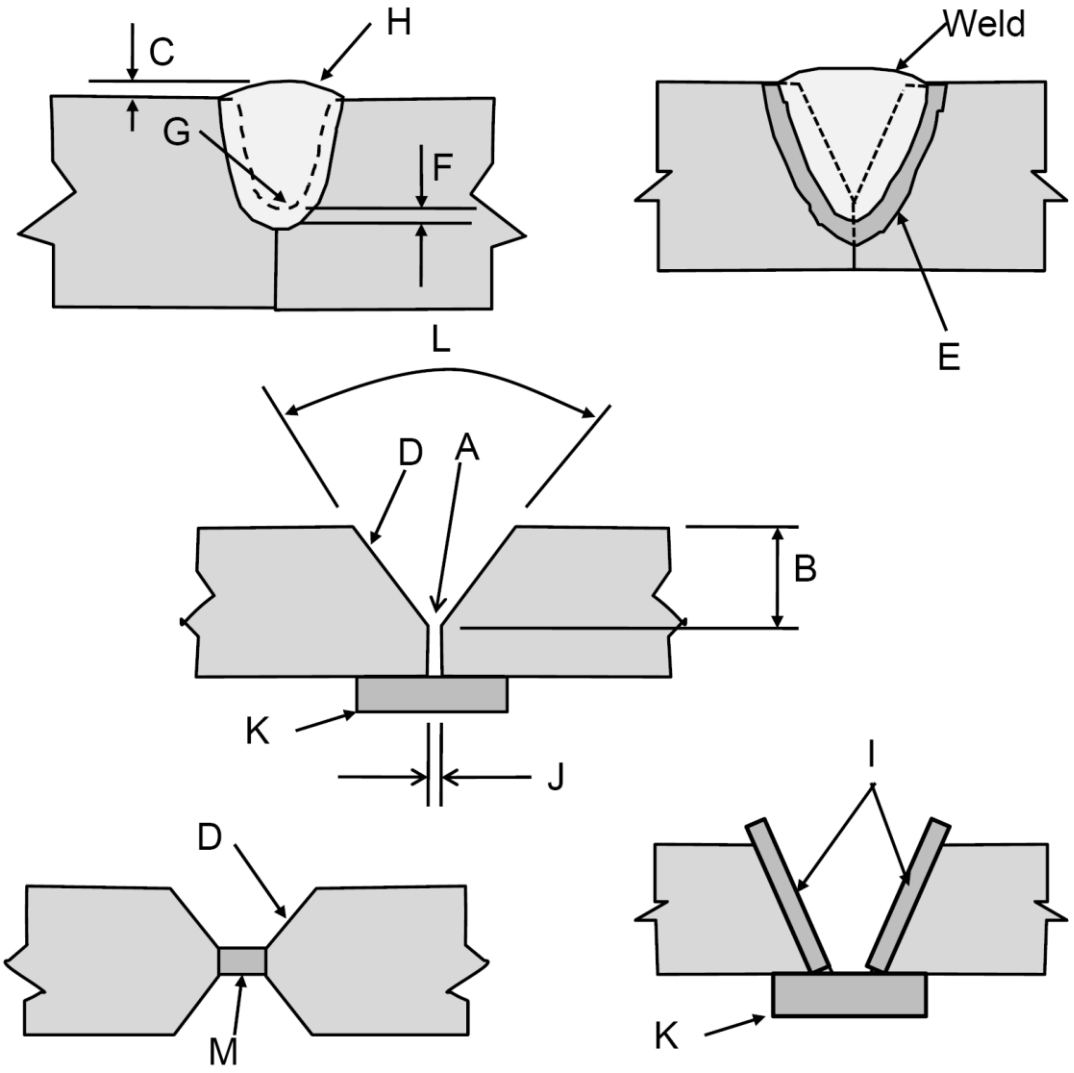


Figure 4-3

4.4 Identify each fillet weld component shown in Figure 4-4 by its letter designation.

_____ leg
_____ toe
_____ throat
_____ convexity
_____ concavity
_____ heat-affected zone
_____ penetration

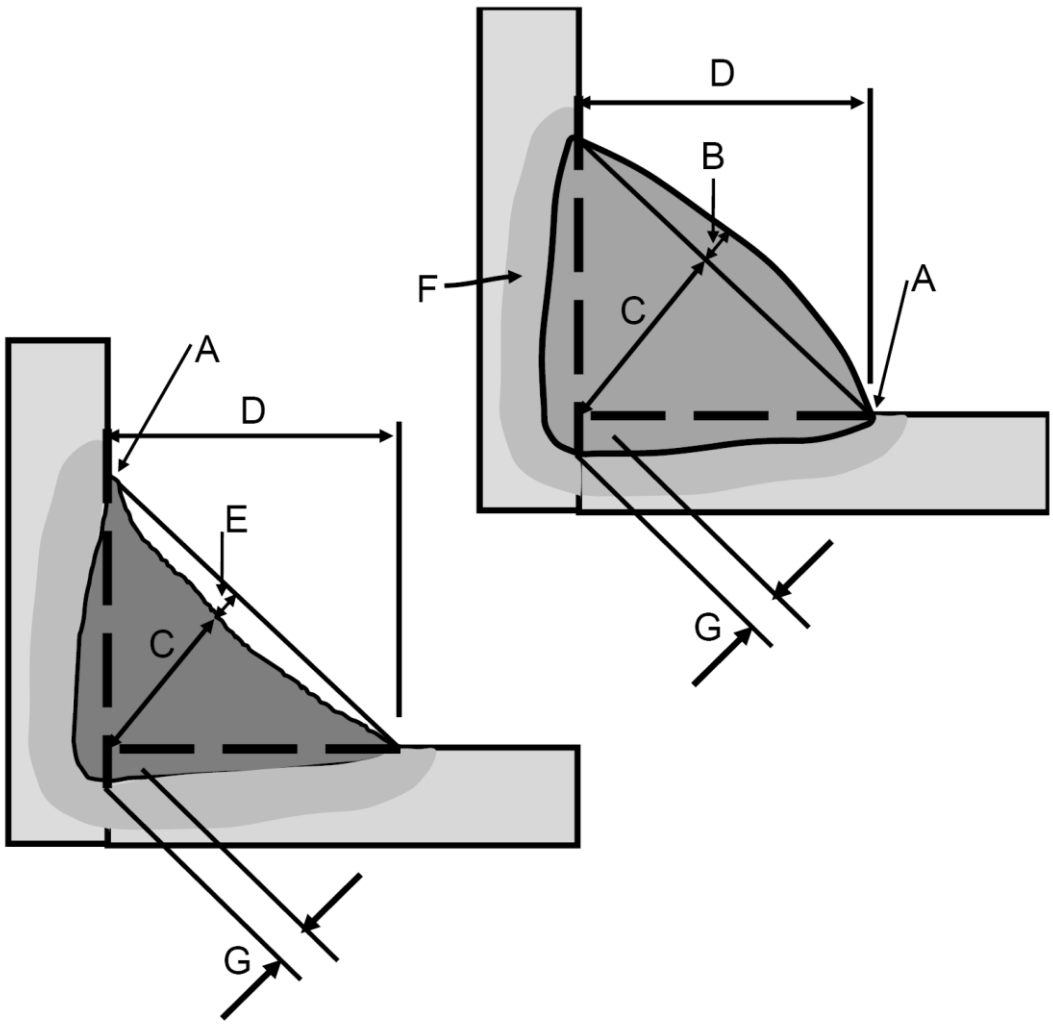


Figure 4-4

4.5 Identify each welded joint type shown in Figure 4-5 by its letter designation.

_____ butt joint
_____ tee joint
_____ edge joint
_____ lap joint
_____ corner joint

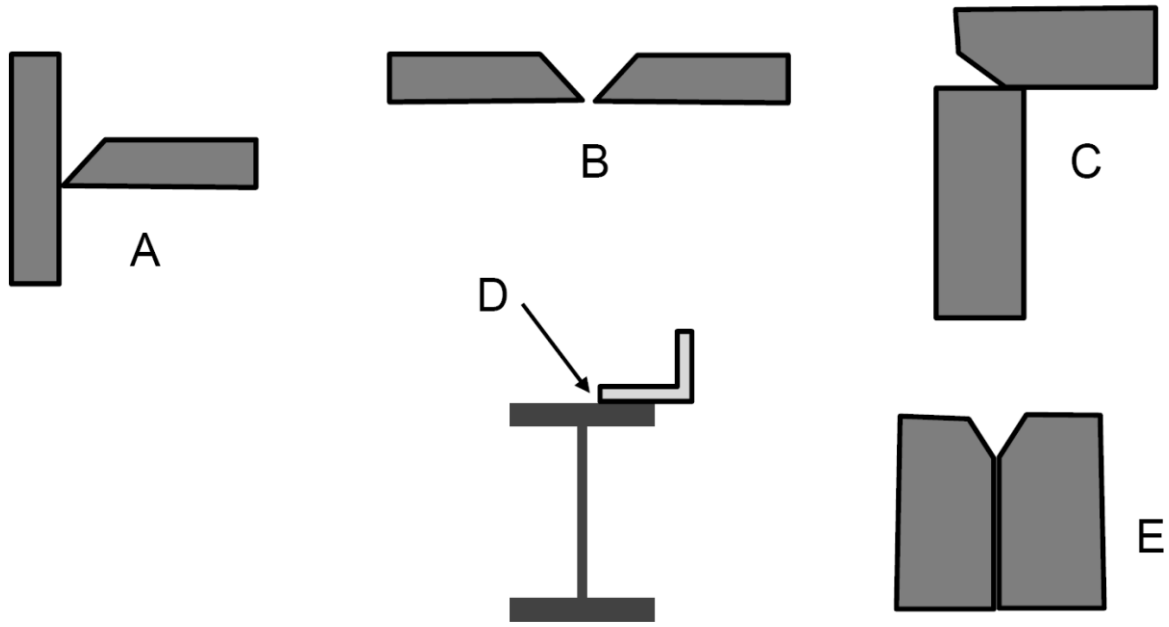


Figure 4-5

4.6 Identify each groove weld type shown in Figure 4-6 by its letter designation.

_____ square groove
_____ single V
_____ double V
_____ single J
_____ double J
_____ single bevel
_____ double bevel
_____ single U
_____ double U
_____ flare bevel
_____ flare V

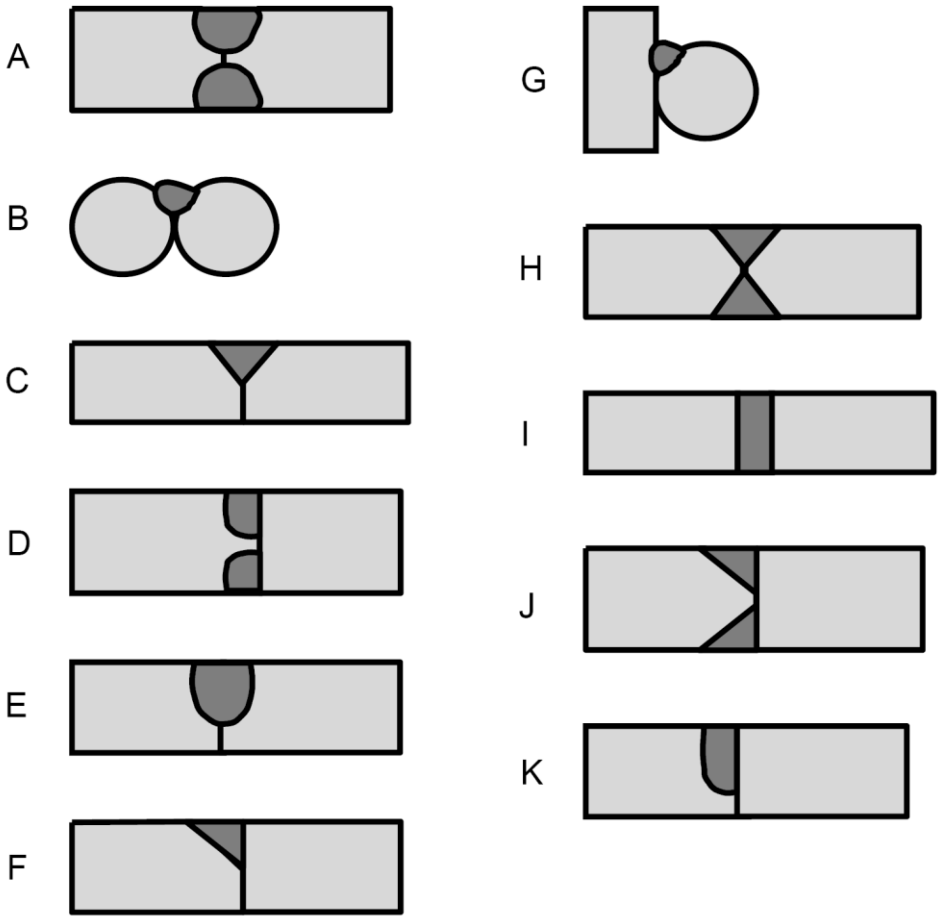


Figure 4-6

4.7 Identify each truss component shown in Figure 4-7 by its letter designation.

_____ top chord
_____ web member
_____ bottom chord
_____ gusset plate
_____ stitch bar
_____ panel point

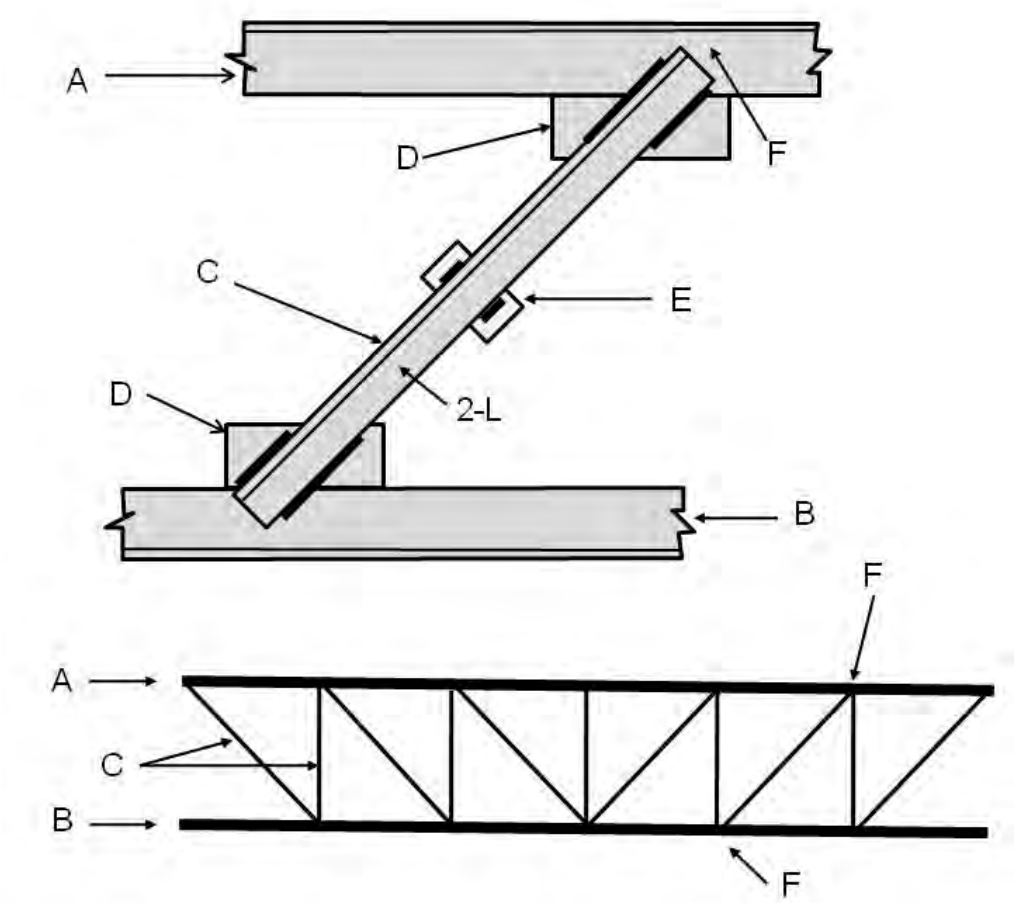


Figure 4-7

4.8 Match the welding terms with their abbreviations.

_____shielded metal arc welding	A. GMAW
_____flux-cored arc welding - self-shielded	B. UT
_____flux-cored arc welding - gas-shielded	C. OC
_____gas metal arc welding	D. CJP
_____submerged arc welding	E. PQR
_____electrogas welding	F. ESW
_____electroslag welding	G. PT
_____gas tungsten arc welding	H. PWHT
_____gas metal arc welding - short circuit transfer	I. SMAW
_____complete joint penetration groove weld	J. ACAC
_____partial joint penetration groove weld	K. CVN
_____Charpy V-notch	L. IQI
_____ultrasonic testing	M. FCAW-G
_____visual testing	N. WPS
_____magnetic particle testing	O. EGW
_____penetrant testing	P. WPQR
_____radiographic testing	Q. FCAW-S
_____heat-affected zone	R. SAW
_____plasma arc cutting	S. PJP
_____air carbon arc cutting	T. GTAW
_____oxyfuel cutting	U GMAW-S
_____welding procedure specification	V. RT
_____procedure qualification record	W VT
_____welding personnel qualification record	X. HAZ
_____image quality indicator	Y. PAC
_____post weld heat treatment	Z. MT

ANSWER KEY	CHAPTER 4 TERMS AND DEFINITIONS

REFERENCES

AISC Steel Construction Manual, 14th Edition, 2011

AWS D1.1:2008 Structural Welding Code - Steel, 2008
AWS D1.1:2010 Structural Welding Code - Steel, 2010

4.1	E	column
	D	anchor bolts / anchor rods
	F	base plate
	A	beam
	H	girder
	B	bracing
	G	girt
	C	purlin

4.2	C	head
	L	diameter
	B	thread
	K	bolt length
	A	shank
	G	thread runout
	H	chamfer circle
	D	washer face
	I	manufacturer's mark
	E	nut face
	J	faying surface
	F	bolt stickout

4.3	A	root
	J	root opening
	L	groove angle
	D	groove face
	G	groove radius / root radius
	H	groove face
	C	reinforcement
	B	depth of preparation
	F	penetration (depth of penetration)
	E	heat-affected zone
	K	backing
	I	weld tab (run-off tab, extension bar)
	M	spacer bar

4.4	D	leg
	A	toe
	C	throat
	B	convexity
	E	concavity
	F	heat-affected zone
	G	penetration

4.5	B	butt joint
	A	tee joint
	E	edge joint
	D	lap joint
	C	corner joint

4.6	I	square groove
	C	single V
	H	double V
	K	single J
	D	double J
	F	single bevel
	J	double bevel
	E	single U
	A	double U
	G	flare bevel
	B	flare V

4.7	A	top chord
	C	web member
	B	bottom chord
	D	gusset plate
	E	stitch bar
	F	panel point

4.8	I	shielded metal arc welding
	Q	flux-cored arc welding - self-shielded
	M	flux-cored arc welding - gas-shielded
	A	gas metal arc welding
	R	submerged arc welding
	O	electrogas welding
	F	electroslag welding
	T	gas tungsten arc welding
	U	gas metal arc welding - short circuit transfer
	P	complete joint penetration groove weld
	S	partial joint penetration groove weld
	K	Charpy V-notch
	B	ultrasonic testing
	W	visual testing
	Z	magnetic particle testing
	G	penetrant testing
	V	radiographic testing
	X	heat-affected zone
	Y	plasma arc cutting
	J	air carbon arc cutting
	C	oxyfuel cutting
	N	welding procedure specification
	E	procedure qualification record
	P	welding personnel qualification record
	L	image quality indicator
	H	post weld heat treatment

STUDY GUIDE	CHAPTER 5 STRUCTURAL STEEL MATERIALS

OBJECTIVE

To become familiar with the structural steels used in steel building construction, their dimensions, and applicable tolerances.

REFERENCES

AISC Steel Construction Manual, 14th Edition, 2011

Part 1 - Dimensions and Properties
Part 2 - General Design Considerations (Tables 2-3, 2-4 and 2-5)

KEY POINTS

AISC Steel Construction Manual, 14th Edition, 2011

Part 1 - Dimensions and Properties

- What sections are used for steel building construction?
- What are the cross-section dimensional tolerances for the shapes used in construction?
- What are the tolerances for straightness?
- Become familiar with the dimension tables for the various structural sections.

Part 2 – General Design Considerations

- What are the available structural steel materials as to ASTM designation and grade?

QUIZ	CHAPTER 5 STRUCTURAL STEEL MATERIALS

5.1 A W14x426 column section has a depth of:

- □ a. 14 inches
- □ b. 15.6 inches
- □ c. $16^{3}/_{4}$ inches
- □ d. $18^{5}/_{8}$ inches

5.2 The flange width of a W18x76 beam is:

- □ a. 18 inches
- □ b. $18^{1}/_{4}$ inches
- □ c. 11 inches
- □ d. will vary by manufacturer

5.3 The nominal weight per foot of a C8x11.5 channel section is:

- □ a. 8 pounds per foot
- □ b. 11.5 pounds per foot
- □ c. between 8 and 11.5 pounds per foot
- □ d. will vary by manufacturer

5.4 The flange width of a W12x22 beam section is specified to be 4 inches, but may vary between:

- □ a. $3^{3}/_{4}$ inches and $4^{1}/_{4}$ inches
- □ b. $3^{13}/_{16}$ inches and $4^{1}/_{4}$ inches
- □ c. $3^{15}/_{16}$ inches and $4^{1}/_{16}$ inches
- □ d. must be exactly 4 inches

5.5 The nominal outside diameter of a 4-inch ASTM A53 Grade B extra-strong pipe is:

- □ a. 4 inches
- □ b. $4^{1}/_{2}$ inches
- □ c. 5 inches
- □ d. varies according to wall thickness

5.6 The depth of a W16x31 beam, outside to outside, measured at the centerline of the web, can range between:

- □ a. 16 inches to $16^{1}/_{4}$ inches
- □ b. $15^{7}/_{8}$ inches to $16^{1}/_{8}$ inches
- □ c. $15^{3}/_{4}$ inches to 16 inches
- □ d. $15^{3}/_{4}$ inches to $16^{1}/_{4}$ inches

5.7 The depth of an S24x100 beam, outside to outside, measured at the centerline of the web, can range between:

□ a. $23\frac{7}{8}$ inches to $24\frac{1}{8}$ inches
□ b. $23\frac{3}{4}$ inches to $24\frac{1}{4}$ inches
□ c. $23\frac{15}{16}$ inches to $24\frac{1}{16}$ inches
□ d. $23\frac{7}{8}$ inches to $24\frac{3}{16}$ inches

5.8 A W12x87 is ordered as a column from the mill with an ordered length of 40 feet. What is the permitted out-of-straightness, measured at the mid-length of the piece?

□ a. $\frac{1}{2}$ inch
□ b. 0.48 inch
□ c. 0.40 inch
□ d. $\frac{3}{8}$ inch

5.9 A W12x87 is ordered as a column from the mill with an ordered length of 60 feet. What is the permitted out-of-straightness, measured at the mid-length of the piece?

□ a. 0.72 inch
□ b. 0.60 inch
□ c. $\frac{9}{16}$ inch
□ d. $\frac{3}{8}$ inch

5.10 An ASTM A500 Grade C hollow structural section is ordered with a nominal wall thickness of $\frac{1}{2}$ inch. What is the permitted range of wall thickness, measured at the flats away from the weld?

□ a. 0.45 inch to 0.55 inch
□ b. 0.475 inch to 0.525 inch
□ c. 0.48 inch to 0.52 inch
□ d. 0.50 inch to 0.55 inch

5.11 What is the ASTM standard for the preferred wide-flange (W) rolled shape?

□ a. ASTM A36
□ b. ASTM A572 Grade 50
□ c. ASTM A992
□ d. ASTM A500 Grade B

5.12 What is the minimum specified yield stress of ASTM A514 steel plate with a thickness of 3 inches?

□ a. 100 ksi
□ b. 110 to 130 ksi
□ c. 110 ksi
□ d. 90 ksi

5.13 Which of the following is not considered a weathering steel?

- □ a. ASTM A242
- □ b. ASTM A588
- □ c. ASTM A847
- □ d. ASTM A852

ANSWER KEY	CHAPTER 5 STRUCTURAL STEEL MATERIALS

REFERENCES

AISC Steel Construction Manual, 14th Edition, 2011

Part 1 - Dimensions and Properties

Part 2 - General Design Considerations (Table 2-3, 2-4 and 2-5)

		AISC Steel Construction Manual, 14th Edition, 2011	
		Page	**Table**
5.1	d	1-22	Table 1-1
5.2	c	1-20	Table 1-1
5.3	b	1-4, 1-36 and 37	Table 1-5
5.4	b	1-119	Table 1-22
5.5	b	1-101	Table 1-19
5.6	c	1-119	Table 1-22
5.7	d	1-121	Table 1-23
5.8	d	1-119	Table 1-22
5.9	c	1-119	Table 1-22
5.10	a	1-125	Table 1-27
5.11	c	2-48	Table 2-4
5.12	d	2-49	Table 2-5
5.13	d	2-48 and 2-49	Tables 2-4 and 2-5

STUDY GUIDE	CHAPTER 6 STEEL FABRICATION

OBJECTIVE

To become familiar with fabricated steel for steel building construction and the applicable tolerances.

REFERENCES

AISC Steel Construction Manual, 14th Edition, 2011
Part 16 - Specifications and Codes

AISC 360-10 Specification for Structural Steel Buildings, 2010
Chapter M - Fabrication and Erection

AISC 303-10 Code of Standard Practice for Steel Buildings and Bridges, 2010
Section 2 - Classification of Materials
Section 3 - Design Drawings and Specifications
Section 5 - Materials
Section 6 - Shop Fabrication and Delivery
Section 8 - Quality Control

KEY POINTS

AISC 360-10 Specification for Structural Steel Buildings, 2010

Chapter M - Fabrication and Erection
- What are the maximum temperatures when using heat for cambering, curving and straightening
- What are the production and quality requirements for thermally cut edges for reentrant corners? For weld access holes? For beam copes?
- What are the finishing requirements for bearing plates and column base plates?
- What are the requirements for surfaces adjacent to field welds?

AISC 303-10 Code of Standard Practice for Steel Buildings and Bridges, 2010

Section 2 - Classification of Materials
- What elements are considered structural steel?
- What elements are not considered structural steel?

Section 3 - Design Drawings and Specifications
- How are discrepancies between the drawings and specifications to be resolved?

Section 5 - Materials
- How are stock materials used?
- How may unidentified material be used?

Section 6 - Shop Fabrication and Delivery
- What are the identification requirements for structural steels in the Fabricator's shop?
- What are the fabrication tolerances for columns? Other members? Cambered members?

Section 8 - Quality Control
- What quality control is expected of the Fabricator?
- How much notice is to be provided the Inspector before work commences?

QUIZ	CHAPTER 6 STEEL FABRICATION

6.1 Preheating to at least 150°F prior to thermal cutting of weld access holes is required for members of what size?

- □ a. hot-rolled shapes with flange thickness exceeding 2 inches
- □ b. welded built-up members with a thickness exceeding 2 inches
- □ c. neither "a" nor "b"
- □ d. both "a" and "b"

6.2 When heat straightening or heat cambering A572 Grade 65 steel, the temperature of the steel shall not exceed:

- □ a. a dark cherry color
- □ b. 300ºF
- □ c. 1200ºF
- □ d. 1330ºF

6.3 Thermal-cut edges subjected to tensile stress must be free of gouges:

- □ a. exceeding an ANSI surface roughness value of 500
- □ b. exceeding an ANSI surface roughness value of 2000
- □ c. greater than $^{3}/_{16}$ inch deep
- □ d. regardless of depth

6.4 Surfaces that are to be field-welded must be free of paint or other materials that would prevent proper welding or produce objectionable fumes:

- □ a. for a distance equal to the weld leg size
- □ b. for a distance at least twice the weld leg size
- □ c. at least 2 inches from the weld
- □ d. unless low-hydrogen electrodes are used

6.5 If the member is to be galvanized:

- □ a. all thermal cut edges must be ground
- □ b. all beam copes must be ground
- □ c. all weld access holes must be ground
- □ d. both "b" and "c" apply

6.6 Structural steel may be defined as:

- □ a. steel elements of the structural steel frames essential to support the design loads
- □ b. any steel material shown on the structural steel plans
- □ c. steel elements attached to the structural steel frame
- □ d. all of the above

6.7 The following items are <u>not</u> considered structural steel:

- □ a. cold-formed steel products
- □ b. grating and metal deck
- □ c. miscellaneous metal such as stairs and railings
- □ d. any of the above

6.8 For buildings, in case of discrepancies between plans (Design Drawings) and specifications:

- □ a. the plans govern
- □ b. the specifications govern
- □ c. plans and specifications govern
- □ d. arbitration is required to resolve the discrepancy

6.9 In case of discrepancies between scale dimensions and figures:

- □ a. the scale dimensions govern
- □ b. the figures govern
- □ c. the average of the scale and figure dimensions is taken
- □ d. the Fabricator may select the dimension desired

6.10 The shop standard material for wide-flange sections is which steel, unless otherwise established by the Fabricator:

- □ a. ASTM A36
- □ b. ASTM A572 Grade 50
- □ c. ASTM A992
- □ d. ASTM A500 Grade B

6.11 If mill material, as received in the shop, fails to meet ASTM A6 for cross-sectional profile or straightness:

- □ a. the Fabricator must return the material to the mill
- □ b. the mill must send qualified personnel to the shop to repair it
- □ c. the Fabricator may perform their own repairs
- □ d. the steel may be used as is

6.12 The Fabricator's use of stock material:

- □ a. is permitted only for minor parts
- □ b. is permitted, provided the stock material meets or exceeds the required ASTM specifications
- □ c. is permitted only if representative material test reports can be provided for the stock material
- □ d. is permitted if both "b" and "c" are met

6.13 The Fabricator's use of material unidentifiable as to specification and grade:

□ a. is prohibited
□ b. is permitted for connection elements only
□ c. is permitted with the permission of the Owner or Owner's Designated Representative for Design
□ d. is permitted without limitation

6.14 Steel must be marked as to grade and special requirements:

□ a. until delivery
□ b. until painting
□ c. until assembly on the shop floor
□ d. until cut to length

6.15 Weld tabs (run-off tabs) are:

□ a. never removed
□ b. always removed
□ c. not removed unless required in the contract documents
□ d. to be removed by thermal cutting and then the cut surfaces are to be ground flush

6.16 The length tolerance for fabricated tier columns with both ends finished for contact bearing, and other elements finished to bear at both ends is:

□ a. 0.01 inch
□ b. $^1/_{32}$ inch
□ c. $^1/_{16}$ inch
□ d. $^1/_8$ inch

6.17 The length tolerance for fabricated beams and other members up to 30 feet in length is:

□ a. 0.01 inch
□ b. $^1/_{32}$ inch
□ c. $^1/_{16}$ inch
□ d. $^1/_8$ inch

6.18 The length tolerance for fabricated beams and other members over 30 feet in length is:

□ a. 0.01 inch
□ b. $^1/_{32}$ inch
□ c. $^1/_{16}$ inch
□ d. $^1/_8$ inch

6.19 The straightness tolerance for columns and other compression members is:

- □ a. 1:500
- □ b. $^1/_{32}$ inch out of straightness
- □ c. $^1/_{1000}$ of the distance between lateral support points
- □ d. $^1/_{1000}$ of the length of the piece

6.20 If $2^1/_2$ inches of camber is specified for a floor beam 40 feet long, what is the permitted camber range when cambered by the Fabricator and measured at the fabricating plant?

- □ a. $2^1/_2$ inches exact
- □ b. 2 inches to 3 inches
- □ c. $2^1/_2$ inches to 3 inches
- □ d. camber is not measured at the plant, it is measured at the job site after erection

6.21 If independent inspection of shop work is specified for a project:

- □ a. the Fabricator must provide notice 24 hours prior to the commencement of work
- □ b. the inspections must be done in a timely manner to minimize disruption of the work
- □ c. the Fabricator must provide access to the work
- □ d. all of the above

ANSWER KEY	CHAPTER 6 STEEL FABRICATION

REFERENCES

AISC Steel Construction Manual, 14th Edition, 2011
Part 16 - Specifications and Codes

AISC 360-10 Specification for Structural Steel Buildings, 2010
Chapter M –Fabrication and Erection

AISC 303-10 Code of Standard Practice for Steel Buildings and Bridges, 2010
Section 2 - Classification of Materials
Section 3 - Design Drawings and Specifications
Section 5 - Materials
Section 6 - Shop Fabrication and Delivery
Section 8 - Quality Control

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6.5	d	16.1-166		M2.2
6.6	a	16.3-5	2.1; 2.2	
6.7	d	16.3-6 & 7	2.2	
6.8	a	16.3-15	3.3	
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6.18	d	16.3-30	6.4.1(b)	
6.19	c	16.3-30 & 31	6.4.2	
6.20	c	16.3-31	6.4.4(a)	
6.21	d	16.3-59	8.5.1; 8.5.2	

STUDY GUIDE	CHAPTER 7 STEEL ERECTION

OBJECTIVE

To become familiar with the erection of structural steel buildings, and the applicable tolerances for the constructed building.

REFERENCES

AISC Steel Construction Manual, 14th Edition, 2011
Part 16 - Specifications and Codes

AISC 360-10 Specification for Structural Steel Buildings, 2010
Chapter M - Fabrication and Erection

AISC 303-10 Code of Standard Practice for Steel Buildings and Bridges, 2010
Section 7 - Erection
Section 8 - Quality Control

KEY POINTS

AISC 360-10 Specification for Structural Steel Buildings, 2010

Chapter M- Fabrication and Erection
- What is the required fit of column splices and between columns and base plates?
- What preparation is required prior to field welding?

AISC 303-10 Code of Standard Practice for Steel Buildings and Bridges, 2010

Section 7 - Erection
- How accurately must anchor rods and bearing devices be placed prior to steel erection?
- What tolerances apply to column plumbness? Column base placement? Member alignment? Member location?
- What is expected by the Erector for the correction of errors?

Section 8 - Quality Control
- What quality control is expected of the Erector?
- How much notice is to be provided the Inspector before work commences?

QUIZ	CHAPTER 7 STEEL ERECTION

7.1 A column splice, either welded or bolted, is permitted to have a gap of _____ between the upper and lower shafts, without repair or shimming.

- □ a. zero (no gap permitted)
- □ b. $^1/_{16}$ inch
- □ c. the root opening tolerance
- □ d. $^1/_4$ inch

7.2 Anchor rods (previously and commonly called anchor bolts) within a given anchor rod group should be set:

- □ a. within $^1/_{16}$ inch center-to-center of one another
- □ b. within $^1/_8$ inch center-to-center of one another
- □ c. within $^1/_4$ inch center-to-center of one another
- □ d. as required to fit within the base plate holes

7.3 Anchor rod groups must be set:

- □ a. within $^1/_4$ inch tolerance from one anchor bolt group to the next
- □ b. within $^1/_2$ inch tolerance from one anchor bolt group to the next
- □ c. within $^1/_4$ inch of the established column line
- □ d. both "a" and "c"

7.4 The top of anchor rods should be set to the proper elevation with the following elevation tolerance:

- □ a. no tolerance, must be exact
- □ b. plus / minus $^1/_2$ inch
- □ c. plus / minus 1 inch
- □ d. no specified tolerance, as best as can be performed by the Contractor

7.5 When checking column plumbness:

- □ a. use the center of the column at each end as the working point
- □ b. use the mid-height of the column as the working point
- □ c. use the center of the column at each beam framing into the column as the working point
- □ d. both "a" and "c"

7.6 For buildings up to 40 feet in height, a column shaft is considered plumb provided:

- □ a. the column plumbness is within 1:500
- □ b. the column plumbness is within 1:1000
- □ c. the column is within $^1/_2$ inch of plumb
- □ d. the column is within 1 inch of plumb

7.7 Column positions may be further restricted beyond just plumbness when:

- □ a. the column is adjacent to an elevator shaft
- □ b. the column is an exterior column
- □ c. (there are no further restrictions)
- □ d. either "a" or "b"

7.8 Floor member elevation is considered acceptable:

- □ a. if the floor is level within 1:500
- □ b. if the floor is level within 1 inch
- □ c. if camber is upward
- □ d. if the ends of the beam or girder are within elevation tolerances where attached to the supporting members

7.9 Adjustable items such as lintels, curb angles and mullions are considered properly placed when they are:

- □ a. straight and plumb within 1:500
- □ b. straight and plumb within 1:1000
- □ c. within $^{1}/_{8}$ inch of the specified location
- □ d. within $^{3}/_{8}$ inch of the specified location

7.10 Prior to placement of other building materials, the acceptance for position and alignment of the steel frame is the responsibility of:

- □ a. the Erector
- □ b. the Contractor pouring the concrete floor slabs
- □ c. the Contractor erecting the façade
- □ d. the Owner's Designated Representative for Construction

7.11 The correction by the Erector of minor misfits during erection:

- □ a. is permitted if using moderate amounts of cutting, welding, reaming or grinding
- □ b. is prohibited without the Engineer's approval
- □ c. is prohibited without the Inspector's approval
- □ d. is prohibited without the Fabricator's approval

7.12 If independent inspection of field work is specified for a project:

- □ a. the Erector must provide notice 24 hours prior to commencement of work
- □ b. the inspections must be done in a timely manner to minimize disruption of the work
- □ c. the Erector must provide access to the work
- □ d. all the above

ANSWER KEY	CHAPTER 7 STEEL ERECTION

REFERENCES

AISC Steel Construction Manual, 14th Edition, 2011
Part 16 - Specifications and Codes

AISC 360-10 Specification for Structural Steel Buildings, 2010
Chapter M - Fabrication and Erection

AISC 303-10 Code of Standard Practice for Steel Buildings and Bridges, 2010
Section 7 - Erection
Section 8 - Quality Control

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7.3	d	16.3-38	7.5.1(b) & (e)	
7.4	b	16.3-38	7.5.1(c)	
7.5	a	16.3-46	7.13(a)	
7.6	a	16.3-49	7.13.1.1	
7.7	d	16.3-49 & 50	7.13.1.1(a), (b), (c) & (d)	
7.8	d	16.3-50	7.13.1.2(b)	
7.9	d	16.3-55	7.13.1.3(a) & (b)	
7.10	d	16.3-56	7.13.3	
7.11	a	16.3-56	7.14	
7.12	d	16.3-56	8.5.1; 8.5.3	

STUDY GUIDE	CHAPTER 8 BOLTING MATERIALS AND CONNECTIONS

OBJECTIVE

To become familiar with the bolting materials and connected parts used in bolted connections.

REFERENCES

AISC Steel Construction Manual, 14th Edition, 2011
Part 7 – Design Considerations for Bolts (Tables 7-14 through 7-19)

AISC 360-10 Specification for Structural Steel Buildings, 2010
Chapter A - General Provisions, Section A3.3
Chapter J - Design of Connections, Section J3
Chapter M - Fabrication and Erection

RCSC Specification for Structural Joints Using High-Strength Bolts, 2009
Section 2 - Fastener Components
Section 3 - Bolted Parts
Section 6 - Use of Washers

KEY POINTS

AISC Steel Construction Manual, 14th Edition, 2011

Part 7 - Design Considerations for Bolts
- What are the types of bolted joints used?
- How is bolt length determined?
- Become familiar with fastener dimensions tables.
- Become familiar with bolt installation clearance tables.

AISC 360-10 Specification for Structural Steel Buildings, 2010

Chapter A, Section A3.3 - Material
- What bolting materials are approved for use?

Chapter J, Section J3 - Bolts and Threaded Parts
- What are the sizes for standard holes? Oversized holes? Slotted holes?
- How close may a fastener come to the edge of a part?
- What is the required minimum pretension for bolts requiring pretension?

Chapter M, Section M2.5 - Bolted Construction
- When may thermally cut holes be used?

RCSC Specification for Structural Joints Using High-Strength Bolts, 2009

Section 2 - Fastener Components
- What fastener materials are approved for use for high-strength bolted connections?
- How are fasteners to be stored?

Section 3 - Bolted Parts
- What surface condition is required in the faying (contact) surface of bolted joints?
- What are the nominal hole dimensions for various bolt diameters and hole types?
- What is the tolerance for hole dimensions?
- What is required when using flame-cut slotted holes?
- When may oversized and slotted holes be used?

Section 6 - Use of Washers
- When are washers required?

QUIZ	CHAPTER 8 BOLTING MATERIALS AND CONNECTIONS

8.1 Bolts, nuts and washers:

- □ a. must be kept in protected storage
- □ b. should not be cleaned of original lubrication
- □ c. may not be used if rusty or dirty, unless tested prior to use for the adequacy of lubrication
- □ d. all of the above

8.2 The length of the bolt must be adequate to provide:

- □ a. at least two threads of stickout beyond the face of the nut
- □ b. the bolt end flush with or beyond the outer face of the nut
- □ c. the threads outside the faying surface
- □ d. the threads outside the outer surface of steel

8.3 For ASTM A325 Type 1 galvanized bolts, the nut shall be of what type:

- □ a. ASTM A563 Grade DH or ASTM A194 Grade 2H, galvanized and lubricated
- □ b. ASTM A563 Grade C, C3, D, DH or DH3, galvanized and lubricated
- □ c. ASTM A194 Grade 2 or 2H, galvanized and lubricated
- □ d. either "b" or "c"

8.4 For ASTM A490 Type 1 bolts, nuts must be:

- □ a. ASTM A563 Grade DH or DH3
- □ b. ASM A194 Grade 2H
- □ c. ASTM A563 Grade C, heavy hex
- □ d. either "a" or "b"

8.5 Washers for ASTM A325 bolts shall be:

- □ a. ASTM A325
- □ b. ASTM F436
- □ c. either ASTM A325 or A490
- □ d. either "a" or "b"

8.6 Paint is permitted in the faying surface of a joint provided:

- □ a. that the joint is a snug tight joint
- □ b. that the joint is a pretensioned joint
- □ c. that the joint is a slip-critical joint, and the coating is qualified in accordance with Appendix A of the RCSC Specification
- □ d. any of the above

8.7 If a hot dip galvanized surface is used in a slip-critical joint, then:

□ a. the surface must be ground until the surface is free of zinc
□ b. the surface must be power wire brushed
□ c. the surface must be roughened by a hand wire brush
□ d. either "b" or "c"

8.8 A hole may be permitted to be larger than the specified nominal diameter by the following amount:

□ a. cannot exceed specified diameter
□ b. $^{1}/_{32}$ inch
□ c. $^{1}/_{16}$ inch
□ d. unlimited if the joint is slip-critical

8.9 The nominal hole diameter for a standard hole is:

□ a. $^{13}/_{16}$ inch
□ b. $^{1}/_{16}$ inch larger than the nominal bolt diameter
□ c. $^{1}/_{8}$ inch larger than the nominal bolt diameter
□ d. $^{1}/_{16}$ inch to $^{3}/_{16}$ inch larger than the nominal bolt diameter, depending on the bolt diameter

8.10 If thermal cutting is used to make a slotted hole in a statically loaded structure:

□ a. the surface roughness cannot exceed 1000 microinches
□ b. the width of the slot cannot exceed the standard hole width plus tolerance
□ c. occasional gouges, not more than $^{1}/_{16}$ inch deep, are permitted
□ d. all of the above

8.11 The use of oversized holes is permitted in slip-critical joints:

□ a. only in the outer plies of the joint
□ b. only in the inner plies of the joint
□ c. in any single ply of the joint
□ d. in any or all plies of the joint

8.12 Long-slotted holes may be used:

□ a. only in the outer plies of the joint
□ b. only in the inner plies of the joint
□ c. in only one ply of each faying surface
□ d. in all plies

8.13 A hardened, beveled washer is required beneath the surface of the bolt head or nut when the slope of the surface beneath the head or nut:

□ a. does not fit perfectly flush
□ b. exceeds a 1:20 slope
□ c. exceeds a 5-degree slope
□ d. is excessive, in the judgment of the installer

8.14 Hardened washers are not required for pretensioned joints, provided:

□ a. the hole is a standard size hole
□ b. the washer is not required for the installation method used
□ c. the bolt is an ASTM A325, or an ASTM A490 installed in steel with a specified minimum yield stress of 40 ksi or higher
□ d. all of the above requirements are satisfied

8.15 A hardened washer is required where:

□ a. the calibrated wrench method of installation is used
□ b. an oversized or short-slotted hole is used beneath the bolt head or nut
□ c. ASTM A490 bolts are installed against ASTM A36 steel
□ d. any of the above

8.16 The length of thread for a 1-inch diameter ASTM A490 bolt is:

□ a. minimum $1^1/_4$ inches
□ b. $1^1/_2$ inches
□ c. $1^3/_4$ inches
□ d. maximum 2 inches

8.17 Direct tension indicators (DTIs) are addressed in which ASTM standard?

□ a. ASTM F436
□ b. ASTM F959
□ c. ASTM A325
□ d. ASTM F2280

8.18 The height of the heavy hex nut required for high-strength bolts, up to bolt diameters of $1^1/_2$ inches, is:

□ a. $^3/_4$ inch
□ b. slightly less than the diameter of the bolt
□ c. $^1/_4$ inch less than the diameter of the bolt
□ d. will vary by manufacturer

8.19 The maximum size of a short-slotted hole for $^7/_8$-inch diameter bolts is:

□ a. $1^1/_{16}$ inch wide and $1^1/_{16}$ inch long
□ b. $^{15}/_{16}$ inch wide and $1^1/_{16}$ inches long
□ c. $^{15}/_{16}$ inch wide and $1^1/_8$ inches long
□ d. $^{15}/_{16}$ inch wide and $2^{13}/_{16}$ inches long

8.20 When long-slotted holes are used in an outer ply for 1-inch diameter ASTM A490 bolts:

□ a. the bolts must be pretensioned
□ b. a bar or plate washer with a minimum $^5/_{16}$ inch thickness with standard holes must be used to cover the slot
□ c. hardened steel ASTM F436 washers are required
□ d. all of the above

8.21 The minimum edge distance from the center of a $^{15}/_{16}$-inch diameter hole, used for a $^7/_8$-inch diameter bolt, to the edge of a rolled beam flange is:

□ a. $^{15}/_{16}$ inch
□ b. $1^1/_2$ inches
□ c. $1^1/_4$ inches
□ d. $1^1/_8$ inches

8.22 When sheared clip angles are used at the end of a beam, and $^7/_8$-inch diameter bolts in standard holes are used to connect the angle to the beam web, the minimum edge distance from the center of the top or bottom bolt to the top or bottom of the clip angle is:

□ a. $^7/_8$ inch
□ b. $1^1/_8$ inches
□ c. $1^1/_4$ inches
□ d. $1^1/_2$ inches

8.23 Thermally cut bolt holes, in statically loaded applications, when made using mechanical guidance:

□ a. are prohibited
□ b. are permitted
□ c. are permitted with a maximum surface roughness of 1000 microinches, and with gouges not exceeding $^1/_{16}$ inch in depth
□ d. are permitted, with gouges not exceeding $^3/_{16}$ inch in depth

ANSWER KEY	CHAPTER 8 BOLTING MATERIALS AND CONNECTIONS

REFERENCES

AISC Steel Construction Manual, 14th Edition, 2011
Part 7 - Design Considerations for Bolts (Tables 7-14 through 7-19)

AISC Specification for Structural Steel Buildings, 2010
Chapter A - General Provisions, Section A3.3
Chapter J - Design of Connections, Section J3
Chapter M - Fabrication and Erection

RCSC Specification for Structural Joints Using High-Strength Bolts, 2009
Section 2 - Fastener Components
Section 3 - Bolted Parts
Section 6 - Use of Washers

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8.5	b	16.2-14		2.5 & Table 2.1	
8.6	d	16.2-17 & 18		3.2.1; 3.2.2(b)	
8.7	c	16.2-18		3.2.2(c)	
8.8	b	16.2-23		Table 3.1, note a	
8.9	b	16.2-23		3.3; Table 3.1	
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8.13	b	16.2-44		6.1.1; 6.2	
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8.15	d	16.2-44 & 45		6.2; 6.2.1; 6.2.2; 6.2.5; Table 6.1	

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8.21	d	16.1-123			Table J3.4
8.22	b	16.1-123			Table J3.4
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		16.1-166			M2.5

STUDY GUIDE	CHAPTER 9 BOLT INSTALLATION AND INSPECTION

OBJECTIVE

To become familiar with the level and methods of bolt installation and tightening, and the tasks of the Bolting Inspector regarding inspection and arbitration of disputes.

REFERENCE

RCSC Specification for Structural Joints Using High Strength Bolts, 2009

Section 7 - Pre-Installation Verification
Section 8 - Installation
Section 9 - Inspection
Section 10 - Arbitration

KEY POINTS

RCSC Specification for Structural Joints Using High Strength Bolts, 2009

Section 7 - Pre-Installation Verification

- When is a bolt tension calibrator required at the job site?
- What is the purpose of the bolt calibration device?
- How often must the bolt tension calibration device be calibrated?
- What testing is required prior to installation of the fasteners?

Section 8 - Installation

- What is the definition of the snug tight condition?
- What methods are approved for pretensioning fasteners?
- When a fastener is pretensioned, what is the minimum pretension required?
- For turn-of-nut installation, how much rotation is required for a given bolt diameter and length?
- When may bolts be reused? What types of bolts may not be reused?

Section 9 - Inspection

- What is the responsibility of the Bolting Inspector?
- May bolts be rejected for being too tight?

Section 10 - Arbitration

- When is arbitration appropriate?
- What steps are taken to establish an arbitration torque?
- How is the arbitration torque applied?
- What are the consequences of a delayed verification inspection?

QUIZ	CHAPTER 9 BOLT INSTALLATION AND INSPECTION

9.1 A bolt calibration device is required for pre-installation testing whenever:

- □ a. slip-critical joints are specified
- □ b. pretensioned joints are specified
- □ c. snug-tightened joints are specified
- □ d. either "a" or "b"

9.2 The purpose of the bolt calibration device is to:

- □ a. verify the quality of the fastener assembly
- □ b. confirm the understanding of the crew of the installation method to be used
- □ c. pre-set torque wrenches, in case arbitration is needed
- □ d. both "a" and "b"

9.3 When high-strength $^{3}/_{4}$-inch A325 bolts are specified to be pretensioned, the minimum pretension:

- □ a. requires 350 foot-pounds of torque
- □ b. must be established by testing in a bolt calibration device
- □ c. is 28 kips, or 28,000 pounds
- □ d. requires the full effort of a worker with a spud wrench, or a few hits of an impact wrench

9.4 For turn of the nut tightening:

- □ a. matchmarking of the bolt and nut is used to determine and verify rotation
- □ b. the wrench operator must observe the rotation of the wrench chuck
- □ c. the nut is turned until the bolt sounds tight
- □ d. either "a" or "b"

9.5 The required rotation for a $^{3}/_{4}$-inch bolt 4 inches long is:

- □ a. $^{1}/_{3}$ turn
- □ b. $^{1}/_{2}$ turn
- □ c. $^{2}/_{3}$ turn
- □ d. 1 turn

9.6 The length of the bolt is measured:

- □ a. from the top of the bolt to the start of the threads
- □ b. from the top of the bolt to the end of the bolt
- □ c. from the underside of the bolt head to the end of the bolt
- □ d. from the underside of the bolt head to the start of the threads

9.7 For the calibrated wrench method, calibration of the installation wrenches is required:

□ a. at the start of every day
□ b. whenever there is a change in lubrication or thread condition
□ c. whenever there is a change in air pressure or source, such as a change in the air hose
□ d. any of the above

9.8 For the twist-off bolt installation method:

□ a. the snugging operation must not sever the splined end
□ b. the manufacturer's washer must be placed directly beneath the nut
□ c. the splined end must be severed upon completion
□ d. all of the above

9.9 For the direct tension indicator (DTI) installation method:

□ a. a sample of DTIs must be tested in a bolt calibration device prior to use
□ b. systematic tightening progression is necessary
□ c. upon completion, the gap must be less than the job inspection gap
□ d. all of the above

9.10 When a joint is properly snug-tightened:

□ a. the nut is finger tight on the bolt
□ b. all the plies in the joint are in firm contact
□ c. the wrench and steel sound like the bolt is tight
□ d. it has been tightened with some effort on a spud wrench

9.11 The snug tight condition is commonly achieved using:

□ a. the full effort on an ordinary spud wrench
□ b. a few impacts of an impact wrench
□ c. a sledge hammer used to bring the parts together
□ d. either "a" or "b"

9.12 The Inspector, during installation, is to verify that:

□ a. the proper materials are being used
□ b. the joints are properly assembled
□ c. the selected method of installation is properly used
□ d. all of the above

9.13 The use of tabulated or calculated torques for inspection:

□ a. is recommended practice
□ b. is not an inspection or arbitration method
□ c. is an acceptable substitute for observation of the installation
□ d. is acceptable for the arbitration of disputes

9.14 Arbitration of disputes is applicable only:

□ a. for slip critical joints, or for pretensioned joints when carrying applied tension
□ b. for joints inspected using the methods of Sections 9.2 and 9.3
□ c. when inspection has not been performed
□ d. "a" and "b" only

9.15 For arbitration of disputes, the inspection torque must be:

□ a. calculated using reasonable friction factors
□ b. taken from an approved table
□ c. must be determined by testing representative bolts in a bolt calibration device
□ d. either "a" or "b"

9.16 Arbitration of disputes must take place:

□ a. prior to installation of the bolts
□ b. within a short period of time following installation of the bolts
□ c. within two weeks of installation
□ d. any time following installation

9.17 After time and exposure of the bolted joints, the use of torque methods:

□ a. is required
□ b. will produce results of questionable accuracy
□ c. may be used for inspection purposes
□ d. is prohibited

9.18 If the required turns using the turn-of-nut method is $^1/_3$ turn (120 degrees), what is the permitted range of rotation?

□ a. 120 degrees to 180 degrees
□ b. 90 degrees to 120 degrees
□ c. 120 degrees to 150 degrees
□ d. 90 degrees to 150 degrees

9.19 If the turns applied using the turn-of-nut method is exceeded by more than the tolerance provided, what should be done?

□ a. accept as is, if the bolt has not broken and the nut has not stripped
□ b. reverse the wrench and turn the nut back until the rotation is within tolerance
□ c. remove and replace the bolt
□ d. remove and reinstall the bolt

9.20 What would cause rejection of the snug-tight condition prior to pretensioning?

□ a. the twist-off tension control bolt spline has been twisted off
□ b. either half or more than half of the DTI gaps have been compressed more than the job inspection gap
□ c. the joint is not in firm contact
□ d. any of the above

ANSWER KEY	CHAPTER 9 BOLT INSTALLATION AND INSPECTION

REFERENCE

RCSC Specification for Structural Joints Using High-Strength Bolts, 2009

Section 7 - Pre-Installation Verification
Section 8 - Installation
Section 9 - Inspection
Section 10 - Arbitration

		AISC Steel Construction Manual, 14th Edition, 2011	RCSC, 2009
		Page	
9.1	d	16.2-47	7.1
9.2	d	16.2-47	7.1
9.3	c	16.2-52	Table 8.1
9.4	d	16.2-53 & 54	8.2.1 (Commentary)
		16.1-119	Also: AISC 360-10 Table J3.1
9.5	b	16.2-54	Table 8.2
9.6	c	16.2-11	Figure C-2.2
9.7	d	16.2-55 & 56	8.2.2 (Commentary)
		16.2-52	8.2
9.8	d	16.2-56	8.2.3
9.9	d	16.2-57	8.2.4
9.10	b	16.2-51	8.1
		16.2-xi	Glossary
9.11	d	16.2-51	8.1 (Commentary)
9.12	d	16.2-59	9.1
		16.2-60	9.2.1
		16.2-61	9.2.2
		16.2-61	9.2.3
		16.2-62	9.2.4
9.13	b	16.2-55	8.2.2 (Commentary)
		16.2-59	9 (not listed in Section 9)
9.14	d	16.2-63	10,
		16.2-26	Table 4.1
9.15	c	16.2-63	10(1)

		AISC Steel Construction Manual, 14th Edition, 2011	RCSC, 2009
		Page	
9.16	b	16.2-63	10
9.17	b	16.2-63	10
9.18	d	16.2-54	Table 8.2 note a
9.19	a	16.2-60	9.2.1
		16.2-53	8.2.1
9.20	d	16.2-56	8.2.3
		16.2-57	8.2.4
		16.2-59	9.1

STUDY GUIDE	CHAPTER 10 WELDING PROCESSES AND FILLER METALS

OBJECTIVE

To become familiar with the requirements for welding processes and filler metals addressed in the AWS D1.1 Structural Welding Code - Steel.

REFERENCE

AWS D1.1:2008 Structural Welding Code - Steel, 2008
AWS D1.1:2010 Structural Welding Code - Steel, 2010
Clause 3 - Prequalification of WPSs
Clause 5 - Fabrication

KEY POINTS

AWS D1.1:2008 Structural Welding Code - Steel, 2008
AWS D1.1:2010 Structural Welding Code - Steel, 2010

Clause 3.2 - Welding Processes
- What welding processes are prequalified?
- What welding processes are code-approved, but not prequalified?

Clause 3.3 - Base Metal / Filler Metal Combinations
- What is a "matching" filler metal?
- When must a matching filler metal be used?
- When may undermatching filler metals be used?
- What are the filler metal requirements when steels of different groups are welded together?
- Become familiar with the format and use of Table 3.1.
- For what steel groups must low-hydrogen SMAW electrodes be used?

Clause 5 - Fabrication
- What filler metals may be used in structural welding when using SMAW? FCAW? GMAW? SAW? ESW
- What storage and exposure requirements apply to filler metals used for SMAW? SAW?

QUIZ	CHAPTER 10 WELDING PROCESSES AND FILLER METALS

10.1 According to AWS D1.1, certification of electrodes is required:

□ a. for all low hydrogen SMAW electrodes
□ b. when requested by the Engineer
□ c. when requested by the Inspector
□ d. when needed to establish WPSs

10.2 AWS A5.1 carbon steel low hydrogen SMAW electrodes that are received in hermetically sealed containers that have been damaged:

□ a. shall be baked in an oven for 4 hours at a minimum of 250ºF prior to use
□ b. shall be baked in an oven for 2 hours between 500ºF and 800ºF
□ c. shall be baked in an oven for 1 hour between 700ºF and 800ºF
□ d. must be returned to the supplier or disposed of

10.3 The permitted exposure time for an E8018-X electrode is:

□ a. 4 hours
□ b. 2 hours, unless otherwise established by test by the electrode manufacturer for the relevant environmental conditions
□ c. 10 hours
□ d. unlimited

10.4 Once an E7015 electrode has been removed from the electrode storage oven, provided it is returned within the maximum exposure time of four hours, the electrode must receive what treatment prior to use:

□ a. returned to the oven and stored for 4 hours at a minimum of 250ºF
□ b. baked in an oven for 2 hours between 500ºF and 800ºF
□ c. baked in an oven for 1 hour between 700ºF and 800ºF
□ d. no special treatment is required

10.5 SAW flux received in damaged packages:

□ a. must have the top inch removed prior to use
□ b. must be dried for at least 4 hours at a temperature of at least 250ºF
□ c. must be dried for at least 1 hour at a temperature of at least 500ºF
□ d. any of the above

10.6 What is required when using reclaimed flux?

□ a. a system for collecting unmelted flux
□ b. a system for adding new flux and mixing with reclaimed flux
□ c. maintaining relatively constant flux composition and particle size distribution
□ d. all of the above

10.7 What is required when using SAW flux from an opened package?

- □ a. must have the top inch removed prior to use
- □ b. must be dried for at least 4 hours at a temperature of at least 250ºF
- □ c. must be dried for at least 1 hour at a temperature of at least 500ºF
- □ d. any of the above

10.8 AWS A5.29 is the standard for low-alloy steel electrodes for which welding process?

- □ a. SMAW
- □ b. GMAW
- □ c. FCAW
- □ d. SAW

10.9 Shielding gasses used for welding are addressed in which AWS A5 filler metal standard?

- □ a. AWS A5.01
- □ b. AWS A5.1
- □ c. AWS A5.18
- □ d. AWS A5.32

10.10 The minimum base metal temperature for welding using ESW without preheat is:

- □ a. -20ºF
- □ b. 0ºF
- □ c. +32ºF
- □ d. +50ºF

10.11 Which welding process is both code-approved and prequalified?

- □ a. ESW
- □ b. GTAW
- □ c. GMAW-S
- □ d. FCAW-S

10.12 When prequalified GMAW or FCAW is used, the power supply shall be:

- □ a. AC (alternating current)
- □ b. DC (direct current)
- □ c. CC (constant current)
- □ d. CV (constant voltage)

10.13 When welding a butt splice between two 1-inch thick pieces of ASTM A709 Grade 50S steel, with matching filler metals, which filler metal would <u>not</u> be acceptable?

- □ a. E7018-1
- □ b. E7016
- □ c. E70T-11
- □ d. E71T-8

10.14 Which SMAW filler metal is prequalified for welding ASTM A36 steel that is $^{7}/_{8}$-inch thick?

- □ a. E6010
- □ b. E7014
- □ c. E7018
- □ d. all of the above

10.15 When welding ASTM A572 Grade 50 to ASTM A572 Grade 65 steel, what matching filler metal classification tensile strength is permitted?

- □ a. 60 ksi (low-hydrogen)
- □ b. 70 ksi (low-hydrogen)
- □ c. 80 ksi
- □ d. both 70 ksi (low-hydrogen) and 80 ksi

10.16 Which carbon steel SMAW filler metals are classified low-hydrogen?

- □ a. E70XX
- □ b. E7014, E7015, E7016, E7018
- □ c. E7015, E7016, E7017, E7018
- □ d. E7015, E7016, E7018, E7028

ANSWER KEY	CHAPTER 10 WELDING PROCESSES AND FILLER METALS

REFERENCE

AWS D1.1:2008 Structural Welding Code - Steel, 2008
AWS D1.1:2010 Structural Welding Code - Steel, 2010
Clause 3 - Prequalification of WPSs
Clause 5 - Fabrication

		AWS D1.1:2008	AWS D1.1:2010
10.1	b	5.3.1.1	5.3.1.1
10.2	b	5.3.2.1; 5.3.2.4	5.3.2.1; 5.3.2.4
10.3	b	5.3.2.2; Table 5.1	5.3.2.2; Table 5.1
10.4	c	5.3.2.2	5.3.2.2
10.5	c	5.3.3.2	5.3.3.2
10.6	d	5.3.3.3	5.3.3.3
10.7	a	5.3.3.2	5.3.3.2
10.8	c	5.3.4.2; Annex V	5.3.4.2; Annex V
10.9	d	3.7.4; 5.3.1.3	3.7.4; 5.3.1.3
10.10	c	5.4.5	5.4.5
10.11	d	3.2.1; 3.2.2	3.2.1; 3.2.2
10.12	d	3.2.4	3.2.4
10.13	c	Table 3.1 (Group II)	Table 3.1 (Group II)
10.14	c	Table 3.1 (Group II)	Table 3.1 (Group II)
10.15	d	3.3; Table 3.1 (Group II to III), Note 1	3.3; Table 3.1 (Group II to III), Note 1
10.16	d	Table 3.1; 5.3.2.1 (Commentary)	Table 3.1; 5.3.2.1 (Commentary)

STUDY GUIDE	CHAPTER 11 WELDED CONNECTIONS

OBJECTIVE

To become familiar with the scope of the AWS D1.1 Structural Welding Code - Steel and its design provisions.

REFERENCE

AWS D1.1:2008 Structural Welding Code - Steel, 2008
AWS D1.1:2010 Structural Welding Code - Steel, 2010
Clause 1 - General Requirements
Clause 2 - Design of Welded Connections (Parts A and B)

KEY POINTS

AWS D1.1:2008 Structural Welding Code - Steel, 2008
AWS D1.1:2010 Structural Welding Code - Steel, 2010

Clause 1 - General Requirements
- What is the limitation on material thicknesses for which AWS D1.1 is applicable?
- For what type of steels is AWS D1.1 applicable?
- For what type of steels and applications is AWS D1.1 not applicable?
- When AWS D1.1 requires "approval," who is responsible for providing such approval?

Clause 2 - Design of Welded Connections

Part A - Common Requirements for Design of Welded Connections (Nontubular and Tubular Members)
- What information is to be provided on the design drawings?
- What is meant by the terms CJP and PJP?
- What is the minimum fillet weld size?
- What is the maximum fillet weld size to be placed along an edge in a lap joint?
- What is the minimum length of an intermittent fillet weld?

Part B - Specific Requirements for Design of Nontubular Connections (Statically or Cyclically Loaded)
- When are filler plates required in splices? What type?
- How large should contouring fillet welds be?
- When are end returns required? Prohibited?
- What are the transition requirements when joining parts of unequal width or thickness?

QUIZ	CHAPTER 11 WELDED CONNECTIONS

11.1 AWS D1.1 applies to carbon and low-alloy steels:

- □ a. of thickness $^{1}/_{16}$ inch and thicker
- □ b. of thickness $^{1}/_{8}$ inch and thicker
- □ c. of thickness $^{3}/_{16}$ inch and thicker
- □ d. no thickness limits apply

11.2 The use of the term "should" in AWS D1.1 indicates:

- □ a. a requirement
- □ b. a choice made by the Fabricator or Erector
- □ c. a choice made by the Inspector
- □ d. a recommendation, but not a requirement

11.3 The use of the term "may" in AWS D1.1 indicates:

- □ a. options provided to the Fabricator, Erector or Engineer
- □ b. options provided to the Inspector
- □ c. that the Inspector's approval is required
- □ d. that the Engineer's approval is required

11.4 What inspection is required by AWS D1.1?

- □ a. Contractor's Inspection (Fabricator, Erector, Manufacturer)
- □ b. Verification Inspection (for Owner or Engineer)
- □ c. both Contractor's Inspection and Verification Inspection
- □ d. neither Contractor's Inspection nor Verification Inspection

11.5 A joint noted as a groove weld with "CJP" in the tail is:

- □ a. a partial joint penetration groove weld
- □ b. a complete joint penetration groove weld
- □ c. a weld that will develop the adjacent base metal in shear and tension
- □ d. unknown

11.6 A joint shown as a groove weld with size noted in parentheses is:

- □ a. a partial joint penetration groove weld
- □ b. a complete joint penetration groove weld for the depth noted
- □ c. a fillet weld
- □ d. a full thickness groove weld

11.7 The effective weld size for a flare-bevel-groove weld made using SMAW, when filled flush, between a plate and a 1-inch diameter rod is:

□ a. $^5/_{16}$ inch
□ b. $^5/_{32}$ inch
□ c. $^1/_2$ inch
□ d. must be determined by qualification testing

11.8 When welding along the edge of a $^5/_{16}$-inch plate in a lap joint, the maximum fillet weld size that should be specified is:

□ a. $^5/_{16}$ inch
□ b. $^5/_{32}$ inch
□ c. $^1/_4$ inch
□ d. $^3/_{16}$ inch

11.9 The minimum length of an intermittent fillet weld is:

□ a. four times the weld size
□ b. 1 inch
□ c. $1^1/_2$ inches
□ d. not limited

11.10 The required thickness of filling of a plug weld in 1-inch thick material onto 2-inches thick material is:

□ a. $^5/_8$ inch
□ b. $^{13}/_{16}$ inch
□ c. 1 inch
□ d. equal to diameter of hole

11.11 The size of a contouring fillet weld over a groove weld:

□ a. need not exceed $^5/_{16}$ inch
□ b. is one-quarter the thickness of the part containing the groove weld
□ c. must exceed one-quarter the thickness of the part containing the groove weld
□ d. is $^3/_8$ inch

11.12 When two highly stressed tension members are spliced using a direct welded butt splice, and the parts are of unequal width or thickness:

□ a. a 1 to $2^1/_2$ slope shall be provided to transition the parts
□ b. the joint must be ultrasonically tested or radiographically tested
□ c. no special requirements apply
□ d. both "a" and "b"

11.13 The minimum spacing between plug welds 1 inch in diameter is:

- □ a. 1 inch
- □ b. 3 inches
- □ c. 4 inches
- □ d. four times the thickness of the material

11.14 When splicing parts of unequal thickness using splice plates, and the difference in thickness of the parts is less than $^{1}/_{4}$ inch:

- □ a. no filler plate is required
- □ b. a filler plate is required, but shall not extend beyond the splice plate
- □ c. the fillet weld size must be increased by an amount equal to the thickness of the filler
- □ d. both "b" and "c"

11.15 If intermittent fillet welds are used to connect two rolled shapes, then:

- □ a. the fillet weld size must not be less than $^{3}/_{16}$ inch
- □ b. the fillet weld lengths must not be less than 3 inches each
- □ c. at least 6 inches of weld length must be provided at each end
- □ d. the maximum spacing of the fillet welds is 24 inches

ANSWER KEY	CHAPTER 11 WELDED CONNECTIONS

REFERENCE

AWS D1.1:2008 Structural Welding Code - Steel, 2008
AWS D1.1:2010 Structural Welding Code - Steel, 2010
Clause 1 - General Requirements
Clause 2 - Design of Welded Connections (Parts A and B)

		AWS D1.1:2008	AWS D1.1:2010
11.1	b	1.2(2)	1.2(2)
11.2	d	1.3.6.2	1.3.6.2
11.3	a	1.3.6.3	1.3.6.3
11.4	a	1.4.1(3); 1.4.2; 1.4.3.1; 1.4.3.2	1.4.1(3); 1.4.2; 1.4.3.1; 1.4.3.2
11.5	b	2.2.5.3	2.3.5.3
11.6	a	2.2.5.3	2.3.5.3
11.7	b	2.3.1.4; Table 2.1	2.4.1.4; Table 2.1
11.8	c	2.3.2.9(2); Figure 2.1(B)	2.4.2.9(2); Figure 2.1(B)
11.9	c	2.3.2.4	2.4.2.4
11.10	a	2.3.5.4	2.4.5.4
11.11	a	2.6.5	2.7.5
11.12	c	2.7.1	2.8.1
11.13	c	2.9.1	2.10.1
11.14	d	2.10.1	2.11.1
11.15	d	2.11.2.1	2.12.2.1

STUDY GUIDE	CHAPTER 12 WELDING PREQUALIFICATION AND QUALIFICATION

OBJECTIVE

To become familiar with the prequalification and qualification requirements of the AWS D1.1 Structural Welding Code - Steel.

REFERENCES

AWS D1.1:2008 Structural Welding Code - Steel, 2008
AWS D1.1:2010 Structural Welding Code - Steel, 2010
Clause 3 - Prequalification of WPSs
Clause 4 - Qualification (Parts A, B and C)

KEY POINTS

AWS D1.1:2008 Structural Welding Code - Steel, 2008
AWS D1.1:2010 Structural Welding Code - Steel, 2010

Clause 3 - Prequalification of WPSs

- What is the definition of prequalification?
- What limitations are placed upon the use of prequalified joints?
- What is included in a prequalified WPS?
- Become familiar with the format and use of Table 3.2.
- What are the minimum preheat and interpass temperatures for various steels and thicknesses?
- How is Annex XI used?
- What are the essential welding parameters that must be provided in a written WPS?
- Become familiar with the format and use of Table 3.7.
- What are the limitations of the various welding parameters to remain prequalified?
- What are the minimum prequalified fillet weld sizes for various applications?
- What are the limitations on the use of plug and slot welds for prequalification?
- Which welding process' groove preparation detail may also be used for other welding processes?
- What special fit-up tolerance applies if automatic welding is being used?
- How is a partial joint penetration groove weld defined?
- What is the minimum prequalified partial joint penetration groove weld size?
- Become familiar with the format and use of Figures 3.3 and 3.4.
- Become familiar with the Legend for Figures 3.3 and 3.4.
- What tolerances are applicable to groove weld detailing and fit-up?
- How are the tolerances applied?

Clause 4 - Qualification

- What requires qualification testing?

Part A - General Requirements

- When is qualification testing not needed?
- Who is responsible for the qualification testing of WPSs?
- For what processes do welding personnel need to perform qualification testing?
- Who is responsible for the qualification testing of welding personnel?
- What is the period of effectiveness for the qualification of a welder? A welding operator? A tack welder?
- What records are required regarding the qualification of welding personnel?
- What records are required regarding the qualification of WPSs?
- What are the definitions and limitations of welding positions for fillet and groove welds?

Part B - Welding Procedure Specification (WPS)

- Become familiar with the organization of Table 4.1 on position limitations for WPSs.
- For WPSs, what Tables provide information regarding the number and types of tests required?
- Become familiar with the organization of Tables 4.2 through 4.4 regarding WPS qualification.
- Who is responsible for WPS preparation?
- What document is required for the preparation of a WPS derived from qualification testing?
- Become familiar with the organization of Tables 4.5 and 4.6 regarding PQR essential variables.
- What are the visual acceptance criteria requirements for WPS qualification?
- What other testing may be required for WPS qualification?
- What welding processes require qualification testing?

Part C - Performance Qualification

- What welding positions qualify welding personnel for welding in other positions?
- What are the thickness limits for welding based upon the thickness of the welder qualification test plates?
- Become familiar with the organization of Tables 4.10 through 4.12
- What tests are conducted on the welding test plates for welding personnel qualification?
- What essential variable items require requalification of welding personnel?
- What SMAW electrodes are the easiest with which to weld? The most difficult?
- What visual weld quality is required for welding personnel qualification?
- When is retesting of welding personnel required?
- How soon may a welder, welding operator or tack welder repeat the qualification test?

QUIZ	CHAPTER 12 WELDING PREQUALIFICATION AND QUALIFICATION

12.1 Which welding process is not considered prequalified for welding A36 steel $^{3}/_{4}$ inch thick or less?

- □ a. SMAW with non low-hydrogen electrodes
- □ b. GMAW-S
- □ c. FCAW-G
- □ d. FCAW-S

12.2 Using the SMAW process to make a CJP groove weld loaded in tension between thin A36 steel and A572 Grade 65 steel, what is the lowest strength classification and type of filler metal required to meet the prequalification and matching requirements of Clause 3?

- □ a. 70 ksi low-hydrogen electrodes
- □ b. 70 ksi, nonlow-hydrogen electrodes
- □ c. 80 ksi low-hydrogen electrodes
- □ d. either 70 or 80 ksi electrodes, either low-hydrogen or nonlow-hydrogen

12.3 When welding A572 Grade 50 steels to one another, which prequalified SMAW filler metals may be used?

- □ a. 70 ksi low-hydrogen electrodes
- □ b. 70 or 80 ksi low-hydrogen electrodes
- □ c. 70 ksi nonlow-hydrogen electrodes
- □ d. qualification testing required for any filler metal

12.4 What is the minimum preheat required for prequalification when welding one piece of $^{5}/_{8}$-inch thick A588 steel to $1^{3}/_{4}$-inches thick A588 steel, when the steel temperature is 60ºF?

- □ a. 50ºF
- □ b. 150ºF
- □ c. 225ºF
- □ d. none

12.5 When welding 1-inch thick A572 Grade 65 steel to $2^{3}/_{4}$-inches thick A572 Grade 50 steel, what is the minimum prequalified preheat temperature?

- □ a. 50ºF
- □ b. 150ºF
- □ c. 225ºF
- □ d. 300ºF

12.6 When the ambient temperature is below 32ºF, $^5/_8$-inch thick A36 steel shall be raised to what minimum temperature prior to welding?

□ a. 50ºF
□ b. 70ºF
□ c. 150ºF
□ d. welding is permitted below 32ºF when using low-hydrogen electrodes

12.7 For nontubular joints, welding in a downward direction is prequalified:

□ a. only when repairing undercut
□ b. only when preheated as required by Table 3.2, with a minimum of 70ºF
□ c. only with a welder qualified for the process and position
□ d. all of the above

12.8 When welding using low-hydrogen SMAW filler metals, what is the minimum prequalified fillet weld size permitted when welding $^1/_2$ inch thick A36 steel to 1 inch thick A992 steel:

□ a. $^1/_8$ inch
□ b. $^3/_{16}$ inch
□ c. $^1/_4$ inch
□ d. $^5/_{16}$ inch

12.9 When welding A992 steels using FCAW filler metal, with one piece $^5/_8$-inch thick and the other 1-inch thick, what is the minimum prequalified fillet weld size?

□ a. $^3/_{16}$ inch
□ b. $^1/_4$ inch
□ c. $^5/_{16}$ inch
□ d. $^3/_8$ inch

12.10 When welding with nonlow-hydrogen SMAW electrodes, with one piece $^1/_4$-inch thick and the other $^5/_8$-inch thick, what is the minimum prequalified fillet weld size?

□ a. $^3/_{16}$ inch
□ b. $^1/_4$ inch
□ c. $^5/_{16}$ inch
□ d. this condition is not permitted

12.11 A 1-inch thick plate is to be plug welded to a 2-inches thick plate. The diameter of the hole shall be:

□ a. $^5/_8$ inch
□ b. 1 inch
□ c. between $1^5/_{16}$ inches and $1^7/_{16}$ inches
□ d. between $1^5/_{16}$ inches and $2^1/_4$ inches

12.12 When plug welding a $^3/_8$-inch thick steel to a $^3/_4$-inch thick steel, the depth of filling shall be:

- □ a. $^3/_{16}$ inch, half the thickness of the material
- □ b. $^5/_{16}$ inch, $^1/_{16}$ inch less than the thickness of the material
- □ c. $^3/_8$ inch, the thickness of the material
- □ d. $^3/_4$ inch

12.13 When using automatic / mechanized SAW for a T-U4a-S, the maximum variation of root opening is:

- □ a. $+^1/_4$ inch, $-^1/_{16}$ inch
- □ b. $+^1/_8$ inch, $-^1/_8$ inch
- □ c. $^1/_8$ inch
- □ d. $+^1/_{16}$ inch, -0 inch

12.14 When welding using FCAW-G by hand for a T-U4a-F, the maximum variation of root opening from the detailed drawing dimension (the fit-up tolerance) is:

- □ a. $+^1/_4$ inch, $-^1/_{16}$ inch
- □ b. $+^5/_{16}$ inch, $-^1/_{16}$ inch
- □ c. $^1/_8$ inch
- □ d. $+^1/_{16}$ inch, -0 inch

12.15 For a CJP in a corner joint using a double bevel groove weld, welded using FCAW, the standard prequalified groove angle used is:

- □ a. 20 degrees
- □ b. 30 degrees
- □ c. 45 degrees
- □ d. 60 degrees

12.16 The maximum thickness of steel that may be joined as a prequalified butt joint using a CJP square groove weld and the GMAW process is:

- □ a. $^1/_8$ inch
- □ b. $^1/_4$ inch
- □ c. $^3/_8$ inch
- □ d. not permitted

12.17 The maximum fit-up variation for the groove angle on a B-U2-S joint is:

- □ a. 20 degrees to 30 degrees
- □ b. +10 degrees, -0 degrees
- □ c. +10 degrees, -5 degrees
- □ d. unlimited

12.18 If a prequalified joint is detailed for welding by SMAW:

□ a. only the SMAW process may be used
□ b. it may also be welded by SAW
□ c. it may also be welded by FCAW or GMAW
□ d. any welding process may be used

12.19 When FCAW-S is used, the minimum PJP groove weld size to be used between two 2-inch thick plates is:

□ a. 2 inches
□ b. $^3/_8$ inch
□ c. $^1/_2$ inch
□ d. 1 inch

12.20 In a butt joint using a prequalified single bevel PJP groove, the depth of preparation required to develop an effective throat of $^1/_2$ inch using SMAW with a groove angle of 50 degrees is:

□ a. $^3/_8$ inch
□ b. $^1/_2$ inch
□ c. $^5/_8$ inch
□ d. not prequalified

12.21 To be considered prequalified, the maximum fillet weld size that may be deposited in a single pass in the horizontal position using the SMAW process is:

□ a. $^1/_4$ inch
□ b. $^5/_{16}$ inch
□ c. $^3/_8$ inch
□ d. not limited

12.22 To be considered prequalified, the maximum thickness of pass, other than the root pass, that may be made using the FCAW process is:

□ a. $^1/_8$ inch
□ b. $^3/_{16}$ inch
□ c. $^1/_4$ inch
□ d. not limited

12.23 For GMAW welding in the horizontal or flat position, when welding nontubular joints, the maximum width of a single pass layer is:

□ a. $^1/_4$ inch
□ b. $^3/_8$ inch
□ c. $^1/_2$ inch
□ d. $^5/_8$ inch

12.24 The responsibility for testing and documentation to establish a welder's qualification lies with:

- □ a. the Inspector or an independent testing agency
- □ b. the employer of the welder (Manufacturer, Fabricator or Erector)
- □ c. the Building Official
- □ d. the Engineer

12.25 The period of effectiveness of a welder's or welding operator's qualification is:

- □ a. six months
- □ b. forever, as long as the welder continues to use the welding process, and does not fail to use the process for a period exceeding six months
- □ c. until revoked because of questions regarding the welder's abilities
- □ d. both "b" and "c"

12.26 Test records documenting welding personnel qualification tests:

- □ a. must be kept for a 7 year period
- □ b. must be kept on file and be made available to anyone authorized to examine them
- □ c. are not required for tack welders
- □ d. may be replaced by welder identification cards indicating process and position of qualification

12.27 A fillet weld made along the slope and on the top of a roof member with a 20 degree slope is considered a:

- □ a. flat weld
- □ b. horizontal weld
- □ c. vertical weld
- □ d. overhead weld

12.28 A WPS (Welding Procedure Specification):

- □ a. must contain all welding variables needed to make a quality weld
- □ b. must be written
- □ c. must be documented with a PQR (Procedure Qualification Record) if not prequalified
- □ d. all of the above

12.29 A welder qualified using a 3F test on plate is also qualified for the following welds:

- □ a. vertical fillets on plate, pipes and tubes
- □ b. vertical, horizontal and flat fillets on plate, pipes and tubes
- □ c. vertical fillets on plate only
- □ d. vertical fillets and horizontal and flat grooves

12.30 Which of the following changes to a qualified FCAW WPS would require a new qualification test and PQR:

□ a. increase in strength of the electrode
□ b. change in amperage or wire feed speed by more than 10%
□ c. change in voltage by more than 7%
□ d. any of the above

12.31 Which of the following changes to a qualified SMAW WPS does <u>not</u> require a new qualification test and PQR:

□ a. increase in electrode strength classification
□ b. a change in type of current (AC / DC) or polarity (DCEN / DCEP)
□ c. decrease of preheat temperature by more than 25ºF
□ d. changing from a nonlow-hydrogen electrode to a low-hydrogen electrode

12.32 Welding using which of the following processes requires qualification testing:

□ a. ESW and EGW
□ b. GTAW-S
□ c. GTAW
□ d. all of the above

12.33 A welder qualified for groove welds by testing on $^{3}/_{8}$-inch thick plates is qualified to make CJP groove welds using the same welding process and in the same position in what thickness material:

□ a. up to and including $^{3}/_{8}$ inch
□ b. $^{1}/_{8}$ inch to $^{3}/_{8}$ inch, inclusive
□ c. $^{1}/_{8}$ inch to $^{3}/_{4}$ inch, inclusive
□ d. unlimited

12.34 A welder qualified for fillet welds using $^{1}/_{2}$-inch thick plates (Option 1) is qualified to weld fillet welds:

□ a. on plates of $^{1}/_{8}$ inch thickness and above
□ b. on joints with skews between 60 degrees and 135 degrees
□ c. any detailed fillet weld
□ d. both "a" and "b"

12.35 A welder qualified using the SMAW process, tested using E6010 electrodes, may weld with:

□ a. any SMAW electrode
□ b. only E6010 electrodes
□ c. any SMAW electrode except low-hydrogen electrodes
□ d. any SMAW electrode except low-hydrogen electrodes, except that EXX28 may be used

12.36 When CVN testing requirements apply, and when FCAW is being used, what change in PQR essential variables would <u>not</u> require a new qualification test and PQR:

□ a. a change in the manufacturer of the FCAW filler metal
□ b. a change in the manufacturer's trade name of the FCAW filler metal
□ c. an increase in heat input
□ d. a decrease in heat input

12.37 When CVN testing requirements apply, and when SMAW is being used, what change in PQR essential variables would <u>not</u> require a new qualification test and PQR:

□ a. a change in the manufacturer of the SMAW electrode
□ b. an increase of more than 100ºF in maximum interpass temperature
□ c. an increase in heat input or weld volume per unit length of weld
□ d. when welding in the vertical position, a change from stringer beads to weave beads

ANSWER KEY	CHAPTER 12 WELDING PREQUALIFICATION AND QUALIFICATION

REFERENCE

AWS D1.1:2008 Structural Welding Code - Steel, 2008
AWS D1.1:2010 Structural Welding Code - Steel, 2010
Clause 3 - Prequalification of WPSs
Clause 4 - Qualification (Parts A, B and C)

		AWS D1.1:2008	AWS D1.1:2010
12.1	b	3.2.2; Table 3.1 (Group I)	3.2.2; Table 3.1 (Group I)
12.2	a	3.3; Table 3.1,Note 1 (Group I to III)	3.3; Table 3.1,Note 1 (Group I to III)
12.3	a	3.3; Table 3.1 (Group II)	3.3; Table 3.1 (Group II)
12.4	b	3.5; 3.5.1; Table 3.2 (Category B)	3.5; 3.5.1; Table 3.2 (Category B)
12.5	c	3.5; 3.5.1; Table 3.2 (Categories B and C)	3.5; 3.5.1; Table 3.2 (Categories B and C)
12.6	b	Table 3.2,Note a	Table 3.2,Note a
12.7	d	3.7.1(1); 4.22; Table 4.12(5)	3.7.1(1); 4.23; Table 4.14(5)
12.8	b	3.9; Table 5.8	3.9; Table 5.8
12.9	b	3.9; Table 5.8	3.9; Table 5.8
12.10	b	3.9; Table 5.8	3.9; Table 5.8
12.11	d	3.10, 2.3.5.1	3.10; 2.4.5.1
12.12	c	3.10; 2.3.5.4(1)	3.10; 2.4.5.4(1)
12.13	c	3.11.3	3.11.3
12.14	a	3.13.1; Figure 3.4 (TC-U4a-GF)	3.13.1; Figure 3.4 (TC-U4a-GF)
12.15	c	Figure 3.4 (TC-U5-GF)	Figure 3.4 (TC-U5-GF)
12.16	c	Figure 3.4 (B-L1a-GF and B-L1b-GF)	Figure 3.4 (B-L1a-GF and B-L1b-GF)
12.17	c	Figure 3.4 (B-U2-S)	Figure 3.4 (B-U2-S)
12.18	c	3.11.1; Notes for Figures 3.3 and 3.4 (Note e)	3.11.1; Notes for Figures 3.3 and 3.4 (Note e)
12.19	b	3.12.2.1(1); Table 3.4	3.12.2.1(1); Table 3.4
12.20	c	Figure 3.3 (BTC-P4)	Figure 3.3 (BTC-P4)
12.21	b	3.7; Table 3.7	3.7; Table 3.7
12.22	c	3.7; Table 3.7	3.7; Table 3.7
12.23	d	3.7; Table 3.7,Note e	3.7; Table 3.7,Note e
12.24	b	4.1.2.2	4.2.2.2
12.25	d	4.1.3.1	4.2.3.1

		AWS D1.1:2008	AWS D1.1:2010
12.26	b	4.2.3	4.3.3
12.27	c	4.2.4; Figure 4.2	4.3.4; Figure 4.2
12.28	d	3.6; 4.6	3.6; 4.7
12.29	b	4.18.1.1; Table 4.10	4.19.1.1; Table 4.10
12.30	d	4.7.1; Table 4.5 (Items 1, 12, 16, 17)	4.8.1; Table 4.5 (Items 1, 12, 16, 17)
12.31	d	4.7.1; Table 4.5 (Items 1, 2, 13, 35)	4.8.1; Table 4.5 (Items 1, 2, 13, 35)
12.32	d	4.15.1	4.16.1
12.33	c	4.18.2.1; Table 4.11(1)	4.19.2.1; Table 4.11(1)
12.34	d	4.18.2.1; Table 4.11(1)	4.19.2.1; Table 4.11(1)
12.35	d	4.22; Tables 4.12 (Item 2); Table 4.13 (Group F3)	4.23; Tables 4.13 (Item 2); Table 4.13 (Group F3)
12.36	d	Table 4.6 (Items 5,9)	Table 4.6 (Items 5,9)
12.37	a	Table 4.6 (Items 5, 7, 9, 10)	Table 4.6 (Items 5, 7, 9, 10)

STUDY GUIDE	CHAPTER 13 WELDED FABRICATION

OBJECTIVE

To become familiar with the fabrication requirements of the AWS D1.1 Structural Welding Code - Steel.

REFERENCE

AWS D1.1:2008 Structural Welding Code - Steel, 2008
AWS D1.1:2010 Structural Welding Code - Steel, 2010
Clause 5 - Fabrication

KEY POINTS

AWS D1.1:2008 Structural Welding Code - Steel, 2008
AWS D1.1:2010 Structural Welding Code - Steel, 2010

Clause 5 - Fabrication

- What steels may be used for weld tabs, backing and spacers?
- What is preheat?
- What are the minimum preheat requirements for various situations?
- How, where and when is preheat temperature measured?
- What is interpass temperature and how is it measured?
- What is required of CJP groove welds made without backing?
- What is backing and from what materials may backing be made?
- What is the minimum size of steel backing?
- When must backing be removed?
- What is the requirement for welding equipment?
- Under what conditions must welding not be performed?
- What tolerances apply to the size, length and location of welds?
- What is the minimum fillet weld size for various situations?
- What is the required quality of the steel prior to welding?
- What procedures must be followed should a discontinuity be discovered at a cut edge?
- How smooth or rough may a thermally cut edge be?
- What is the minimum radius for re-entrant corners?
- What are the dimensions and preparation methods required for weld access holes?
- When do special quality provisions apply for weld access holes?
- What are the quality requirements for temporary and tack welds?
- What provisions should be taken to minimize or control shrinkage and distortion?
- What assembly tolerances are applicable for fillet-welded joints?
- What assembly tolerances are applicable for groove-welded joints?
- How closely must butt joints be aligned?
- Become familiar with the various types of tolerances applicable to welded members and their connections.
- How much convexity is acceptable for a fillet weld?
- How much reinforcement is permitted for a groove weld?
- If specified to be flush, what tolerances apply to the weld and steel surfaces?
- If specified to be finished, what tolerances apply to the finished surface?
- What limitations are applied to the welding of plug and slot welds?
- If a specific type weld discontinuity needs repair, what repair is required?

- What are the temperature limits for heat straightening?
- If the base metal must be repaired, what action must be taken?
- What options are available for mislocated holes?
- What limitations are applied to peening?
- What repair is required when an arc strike occurs?
- How clean must the weld surface be during and after welding?
- What are weld tabs?
- When must weld tabs be removed, and to what finish after removal?

QUIZ	CHAPTER 13 WELDED FABRICATION

13.1 Weld tab material:

□ a. may be any structural steel
□ b. may be any prequalified steel or a steel listed in Table 4.9, or the steel qualified for welding
□ c. must be the same steel as being welded
□ d. may be steel, copper, ceramic, flux, glass tape, iron powder or similar materials

13.2 In double groove welds, spacer bars, if used,:

□ a. may be any structural steel
□ b. must be of the same steel being welded
□ c. may be of any of the prequalified steels
□ d. may be copper, ceramic or steel

13.3 Welding equipment must be:

□ a. calibrated annually
□ b. in adequate condition to enable the WPS to be followed and the welds to achieve the required results
□ c. constant voltage
□ d. capable of both constant voltage and constant current welding

13.4 Prior to welding, preheat is measured:

□ a. at a distance of 3 inches away from the joint, or at a distance equal to the thickness of material when over 3 inches thick
□ b. at a distance of 1 inch away from the joint, or at a distance equal to the thickness of the thinner material, whichever is less
□ c. at a distance equal to the thickness of the material away from the joint
□ d. within the joint itself

13.5 Steel backing used for SMAW should be at least what thickness?

□ a. $^1/_8$ inch
□ b. $^3/_{16}$ inch
□ c. $^3/_8$ inch
□ d. equal to the root opening dimension

13.6 Backing in statically loaded structures:

□ a. must be removed
□ b. must be welded full length
□ c. must be removed when required by the Engineer
□ d. must either be removed or welded full length

13.7 For gas-shielded welding processes, the wind or draft in the vicinity of the welding:

□ a. must be reduced by using a tent or similar shield
□ b. is limited in velocity to 5 miles per hour
□ c. must not be a high wind
□ d. both "a" and "b"

13.8 Welding must not be done:

□ a. when the ambient temperature around the welding area is below 0ºF
□ b. when the surfaces are wet or exposed to rain or snow
□ c. when the welding area is exposed to high wind velocities
□ d. any of the above

13.9 Prior to welding, the surface of the steel must be free of the following materials if they would prevent proper welding or produce objectionable fumes:

□ a. material surface defects such as cracks, tears or fins
□ b. loose or thick mill scale
□ c. rust, moisture and grease
□ d. all of the above

13.10 For materials up to 4 inches thick, thermal cut edges must be:

□ a. smooth within ANSI B46.1 surface roughness value of 1000 microinches, (AWS C4.1-77, Sample 3) and free of gouges
□ b. free of all nicks and gouges exceeding $^1/_8$ inch
□ c. straight within $^1/_8$ inch of a line drawn from end to end
□ d. cut only with automatic thermal cutting equipment

13.11 For heavy shapes, thermally cut weld access holes must be:

□ a. preheated prior to cutting
□ b. ground smooth following cutting
□ c. checked using PT or MT for cracks
□ d. all the above

13.12 For multipass tack welds made using SMAW that will be welded over using FCAW filler metal:

□ a. preheat is not required, even when required by AWS D1.1, Table 3.2
□ b. are acceptable without cascading or smoothing the tack weld ends
□ c. a written WPS is not required
□ d. none of the above

13.13 The maximum gap permitted between two parts being joined with fillet welds is:

□ a. $1/16$ inch, without increasing weld size
□ b. $3/16$ inch, if both weld legs are increased in size equal to the amount of the gap
□ c. $5/16$ inch, but only for materials over 3 inches thick, if both weld legs are increased in size equal to the amount of the gap, and if backing is used
□ d. all of the above

13.14 When parts are joined using a butt joint, the maximum misalignment is:

□ a. $1/16$ inch
□ b. 10% of the thickness of the thinner part, or $1/8$ inch, whichever is smaller
□ c. $1/4$ inch
□ d. limited only when subject to cyclic loading

13.15 For a butt joint of two $1/2$-inch thick plates to be joined using a groove weld, with a specified root opening of 0 inch, the maximum root opening permitted that can be repaired using welding, without seeking the Engineer's approval, is:

□ a. $1/8$ inch
□ b. $1/4$ inch
□ c. $3/4$ inch
□ d. 1 inch

13.16 The maximum out of straightness of a built-up column 40 feet in length is:

□ a. $1/4$ inch
□ b. $3/8$ inch
□ c. $1/2$ inch
□ d. $15/16$ inch

13.17 For a typical welded beam or girder 50 feet in length with a specified camber of $2\,1/2$ inches, the actual camber measured at midspan may range between:

□ a. $1\,1/2$ inches to $3\,1/2$ inches
□ b. $2\,1/2$ inches to $3\,1/4$ inches
□ c. $2\,1/2$ inches to 4 inches
□ d. $2\,1/8$ inches to $2\,7/8$ inches

13.18 When welding a $1/2$-inch thick plate to a 1-inch thick column flange using SMAW low-hydrogen electrodes, the minimum fillet weld size permitted is:

□ a. $1/8$ inch
□ b. $3/16$ inch
□ c. $1/4$ inch
□ d. $5/16$ inch

13.19 For a girder detailed to be 48 inches deep, the permitted depth upon completion is:

□ a. 48 inches to $48^{1}/_{8}$ inches
□ b. 48 inches to $48^{1}/_{2}$ inches
□ c. $47^{13}/_{16}$ inches to $48^{3}/_{16}$ inches
□ d. $47^{13}/_{16}$ inches to $48^{5}/_{16}$ inches

13.20 Except at outside welds in corner joints, a fillet weld with $^{5}/_{16}$-inch size is considered to have excess convexity when the measured convexity exceeds:

□ a. $^{1}/_{16}$ inch
□ b. $^{1}/_{8}$ inch
□ c. $^{3}/_{16}$ inch
□ d. $^{5}/_{16}$ inch

13.21 For a groove weld in a butt joint with 1-inch thick plates, the maximum height of reinforcement permitted is:

□ a. $^{1}/_{32}$ inch
□ b. $^{1}/_{16}$ inch
□ c. $^{1}/_{8}$ inch
□ d. no reinforcement is permitted

13.22 For a weld found to exhibit excessive piping porosity, the repair is to:

□ a. remove the entire weld and reweld
□ b. weld over the porosity at a slower travel speed to remelt the area
□ c. remove the unacceptable portion of weld and replace with new weld
□ d. grind the weld surface until porosity is no longer present

13.23 For a weld found with a crack, the repair method shall include the following step(s):

□ a. use NDT such a MT or PT to determine the extent of crack
□ b. remove the weld metal for a distance 2 inches beyond the end of the crack
□ c. reweld the area removed
□ d. all of the above

13.24 An A588 member in need of straightening or cambering may be heated:

□ a. to 600ºF maximum
□ b. to 1100ºF maximum
□ c. to 1200ºF maximum
□ d. to a dark cherry color

13.25 When holes are made in a member in the wrong location of a statically loaded member, a suitable repair option is to:

- □ a. leave the holes open
- □ b. fill the open holes with bolts
- □ c. fill the holes with weld metal using a special repair procedure, with NDT as required for groove welds
- □ d. any of the above

13.26 Peening is not permitted:

- □ a. without the Engineer's approval
- □ b. on the root or cap layer
- □ c. on the base metal
- □ d. both "b" and "c"

13.27 Weld tabs in cyclically loaded nontubular structures:

- □ a. need not be removed
- □ b. need not be removed unless required by the Engineer
- □ c. must be removed
- □ d. must be removed and the ends made smooth and flush

ANSWER KEY	CHAPTER 13 WELDED FABRICATION

REFERENCE

AWS D1.1:2008 Structural Welding Code - Steel, 2008
AWS D1.1:2010 Structural Welding Code - Steel, 2010
Clause 5 - Fabrication

		AWS D1.1:2008	AWS D1.1:2010
13.1	b	5.2.2.1	5.2.2.1
13.2	b	5.2.2.3	5.2.2.3
13.3	b	5.11	5.11
13.4	a	5.6	5.6
13.5	b	5.10.3	5.10.3
13.6	c	5.10.5	5.10.5
13.7	b	5.12.1	5.12.1
13.8	d	5.12.2	5.12.2
13.9	d	5.15	5.15
13.10	a	5.15.4.2; 5.15.4.3; 5.15.4.4	5.15.4.2; 5.15.4.3; 5.15.4.4
13.11	d	5.17.2; Figure 5.2 (Note)	5.17.3; Figure 5.2 (Note)
13.12	d	5.18.1(1); 5.18.4(2)	5.18.1(1); 5.18.4(2)
13.13	d	5.22.1	5.22.1
13.14	b	5.22.3	5.22.3
13.15	c	5.22.4.1 and 5.22.4.3	5.22.4.1 and 5.22.4.3
13.16	b	5.23.1	5.23.1
13.17	b	5.23.3; Table 5.6	5.23.3; Table 5.6
13.18	b	5.14; Table 5.8	5.14; Table 5.8
13.19	c	5.23.9	5.23.9
13.20	b	5.24.1; 5.24.3; Figure 5.4(B)	5.24.1; Table 5.9; Figure 5.4(E); Table 5.10 (Schedule C)
13.21	c	5.24.4; Figure 5.4(D), Note b	5.24.3; Table 5.9; Figure 5.4(A); Table 5.10 (Schedule A)
13.22	c	5.26.1.3	5.26.1.3
13.23	d	5.26.1.4	5.26.1.4
13.24	c	5.26.2	5.26.2
13.25	d	5.26.5(1)	5.26.5(1)
13.26	d	5.27	5.27
13.27	d	5.31.3	5.31.3

STUDY GUIDE	CHAPTER 14 WELDING INSPECTION

OBJECTIVE

To become familiar with the welding inspection and nondestructive testing (NDT) requirements of the AWS D1.1 Structural Welding Code - Steel.

REFERENCE

AWS D1.1:2008 Structural Welding Code - Steel, 2008
AWS D1.1:2010 Structural Welding Code - Steel, 2010
Clause 6 - Inspection

KEY POINTS

AWS D1.1:2008 Structural Welding Code - Steel, 2008
AWS D1.1:2010 Structural Welding Code - Steel, 2010

Clause 6 - Inspection

Part A - General Requirements
- What are the categories of inspection?
- What are the categories of Inspectors?
- What are the credentials of a qualified Inspector?
- What tasks should an Inspector perform?
- What inspection records are required?
- What methods be used to identify inspected joints or members?

Part B - Contractor Responsibilities
- What are the obligations of the Contractor regarding inspection?

Part C - Acceptance Criteria
- What is the Engineer's responsibilities regarding inspection?
- What is the visual weld quality acceptance criteria?
- What is the acceptance criteria for liquid penetrant and magnetic particle testing?

Part D - NDT Procedures
- What level of certification is needed to perform nondestructive testing?
- How much nondestructive testing is to be performed?

Part E - Radiographic Testing (RT)
- What should a radiographer do to document the quality of the radiographs?

Part F - Ultrasonic Testing (UT) of Groove Welds
- How often should an ultrasonic testing technician verify the calibration of the equipment?

QUIZ	CHAPTER 14 WELDING INSPECTION

14.1 The length of qualification for an Inspector is:

- □ a. three years
- □ b. until the completion of the project being inspected
- □ c. as determined by the Engineer
- □ d. forever, as long as the Inspector remains active in inspection and has the ability to do the work

14.2 Welding Inspectors shall have their eyes examined and demonstrate satisfactory vision:

- □ a. every three years
- □ b. without their glasses or contact lenses
- □ c. at the start of each inspection project or new employment
- □ d. when requested by the Contractor, Fabricator or Erector

14.3 The Inspector's list of duties includes:

- □ a. inspection of materials
- □ b. inspection of welding procedures and welding equipment
- □ c. inspection of welding personnel qualifications
- □ d. all of the above

14.4 Upon completion of inspection of a particular weld or piece, the Inspector must:

- □ a. place a mark by each weld inspected
- □ b. place a mark on each piece inspected
- □ c. record in a record book or on a drawing that the inspection has been completed
- □ d. any of the above

14.5 Unless otherwise specified, visual inspection of all welds is the responsibility of:

- □ a. the Contractor
- □ b. the Inspector
- □ c. the Engineer
- □ d. all of the above

14.6 If a weld fails to satisfy the criteria of AWS D1.1:

- □ a. the weld must be repaired or replaced
- □ b. the Engineer may accept the weld based upon analysis, experience or judgment
- □ c. in lieu of repair, the Contractor may accept the responsibility should it fail in service
- □ d. additional nondestructive testing must be performed

14.7 If magnetic particle or penetrant testing is required:

□ a. the weld quality criteria is the same as the UT acceptance criteria
□ b. the weld quality criteria is the same as the RT acceptance criteria
□ c. the weld quality criteria is the same as the visual acceptance level
□ d. UT or RT inspection is also required to check for subsurface discontinuities

14.8 Nondestructive testing of welds made in all <u>but</u> ASTM A514 or A517, or the ASTM A709 equivalent, quenched and tempered steels may begin:

□ a. as soon as the welds are completed
□ b. as soon as the welds have dropped below the preheating temperature
□ c. as soon as the welds have cooled to ambient temperature
□ d. 48 hours after completion

14.9 A $^{5}/_{16}$-inch fillet weld is permitted to underrun in size and length:

□ a. up to $^{1}/_{8}$ inch undersized maximum, but may not be underlength
□ b. up to $^{1}/_{8}$ inch undersized maximum, and may be underlength for up to 10% of the specified weld length
□ c. up to $^{1}/_{8}$ inch undersized maximum for 10% of the weld length maximum, but may not be underlength
□ d. may not be undersized, but may be 10% underlength if weld size is full size or larger

14.10 In a statically loaded nontubular structure, a $^{1}/_{4}$-inch fillet weld 12 inches long, oriented parallel to the direction of stress, made on a $^{3}/_{4}$-inch thick material, is permitted to have undercut in the material:

□ a. $^{1}/_{16}$ inch deep for the full length of the weld
□ b. $^{1}/_{32}$ inch deep for the full length of the weld
□ c. $^{1}/_{32}$ inch deep for the full length of the weld, plus an additional $^{1}/_{32}$ inch undercut ($^{1}/_{16}$ inch total) for 2 inches of length
□ d. 0.01 inch deep for the full length of weld

14.11 Nondestructive testing other than visual inspection may be performed by personnel qualified to the following ASNT SNT-TC-1a level(s):

□ a. Level I if under the supervision of a Level II, or a Level II
□ b. Level II
□ c. Level III
□ d. Level II or Level III

14.12 Testing requirements which call for groove welds to be ultrasonically examined for their entire length would be referred to as:

□ a. full testing
□ b. partial testing
□ c. spot testing
□ d. periodic inspection

14.13 Unless otherwise approved by the Engineer, when radiographic inspection is required on groove welds in butt joints over $^1/_2$-inch thick:

□ a. weld tabs must remain in place until completion of the testing
□ b. weld tabs must be removed prior to testing
□ c. weld tabs must be removed, unless permitted to remain by the Engineer
□ d. weld tabs must be removed and edge blocks are required

14.14 Ultrasonic testing procedures as provided in Part F of AWS D1.1 are considered effective for steels in the following thickness range:

□ a. $^1/_2$ inch to 4 inches
□ b. $^1/_8$ inch to 4 inches
□ c. $^5/_{16}$ inch to 8 inches
□ d. unlimited

14.15 Recalibration of the ultrasonic testing unit is required:

□ a. when there are changes to the electrical energy source
□ b. when the transducer is changed
□ c. at thirty-minute time intervals
□ d. when any of the above occurs

ANSWER KEY	CHAPTER 14 WELDING INSPECTION

REFERENCE

AWS D1.1:2008 Structural Welding Code - Steel, 2008
AWS D1.1:2010 Structural Welding Code - Steel, 2010
Clause 6 - Inspection

		AWS D1.1:2008	AWS D1.1:2010
14.1	d	6.1.4.2	6.1.4.2
14.2	a	6.1.4.4	6.1.4.4
14.3	d	6.2; 6.3; 6.4	6.2; 6.3; 6.4
14.4	d	6.5.4	6.5.4
14.5	a	6.1.2.1; 6.1.2.2; 6.6.1	6.1.2.1; 6.1.2.2; 6.6.1
14.6	b	6.5.3; 6.8	6.5.3; 6.8
14.7	c	6.10	6.10
14.8	c	6.11; Table 6.1(5)	6.11; Table 6.1(5)
14.9	c	Table 6.1(6)	Table 6.1(6)
14.10	c	Table 6.1(7A)	Table 6.1(7A)
14.11	a	6.14.6.1	6.14.6.1
14.12	a	6.15.1	6.15.1
14.13	d	6.17.3.1; 6.17.13	6.17.3.1; 6.17.13
14.14	c	6.20.1	6.20.1
14.15	d	6.25.3	6.25.3

ANSWER KEY	CHAPTER 15 STUD WELDING

OBJECTIVE

To become familiar with the installation, inspection and testing of welded stud shear connectors for composite construction.

REFERENCES

AWS D1.1:2008 Structural Welding Code - Steel, 2008
AWS D1.1:2010 Structural Welding Code - Steel, 2010
Clause 7 - Stud Welding

AISC 360-10 Specification for Structural Steel Buildings, 2010
Chapter I - Design of Composite Members

KEY POINTS

AWS D1.1:2008 Structural Welding Code - Steel, 2008
AWS D1.1:2010 Structural Welding Code - Steel, 2010

Clause 7.2 - General Requirements
- What types of shear studs are approved for use on composite construction?
- When must studs have arc shields and flux at the base?
- What surface quality is required for studs?

Clause 7.3 - Mechanical Requirements
- What documentation may be required for shear studs?

Clause 7.4 - Workmanship
- What condition must the base metal be in prior to welding a shear stud?
- How accurately must studs be placed?
- Must arc shields be removed?
- What visual acceptance criteria is applicable to stud welds?

Clause 7.5 - Technique
- Studs should not be welded under what conditions?
- Studs may be welded by other processes under what conditions?

Clause 7.6 - Stud Application Qualification Requirements
- When is stud base qualification testing required?
- How is stud base qualification testing performed?
- How many test stud welds are required?

Clause 7.7 - Production Control
- When is stud welding procedure qualification performed?
- What is the acceptance criteria for procedure qualification?
- How are welding operators qualified to make stud welds?
- What repair may be performed for defective stud welds?

Clause 7.8 - Fabrication and Verification Inspection Procedures

- What is the visual acceptance criteria for a completed production stud weld?
- What bend testing is required for production studs?
- Must studs be bent back after bend testing?

AISC 360-10 Specification for Structural Steel Buildings, 2010

Chapter I - Design of Composite Members

- What are the limitations of use for studs and concrete slabs with formed steel deck?
- What is the maximum diameter of stud, relative to the steel thickness to which it is attached?
- What is the minimum length of stud, relative to its diameter, when used on composite beams?
- What is the minimum lateral cover of a stud embedded in concrete?
- What is the minimum spacing of studs?
- What is the maximum spacing of studs?

QUIZ	CHAPTER 15 STUD WELDING

15.1 The shear connectors used for composite beam construction shall be:

- □ a. Type A
- □ b. Type B
- □ c. Type C
- □ d. any of the above

15.2 Studs of what diameter and larger are to be furnished with a stabilizing flux base:

- □ a. $^1/_8$ inch
- □ b. $^5/_{16}$ inch
- □ c. $^3/_4$ inch
- □ d. all stud diameters

15.3 The Engineer may require submittal of the following:

- □ a. stud manufacturer's certification that the studs comply with the AWS requirements
- □ b. certified copies of the stud manufacturer's latest mechanical test reports
- □ c. certified mill test reports on the material from which the studs are manufactured
- □ d. all of the above

15.4 Cracks or bursts in the heads of the studs are permitted:

- □ a. without limitation
- □ b. only with the Engineer's approval
- □ c. only if they do not extend more than half way from perimeter to stud shank
- □ d. both "b" and "c"

15.5 Studs for composite construction:

- □ a. may be epoxy-coated prior to welding to minimize corrosion
- □ b. may be coated prior to the welding to increase bond with the concrete
- □ c. must be free of all coatings
- □ d. any of the above

15.6 The surface to which the studs are to be welded must be free of the following items prior to welding, or limited to a small amount that would not cause faulty welds:

- □ a. rust and mill scale
- □ b. paint
- □ c. moisture
- □ d. all of the above

15.7 Arc shields that show dampness may be used:

□ a. provided they are dried for 2 hours at a minimum of 250ºF prior to use
□ b. provided the flash around the studs as welded looks satisfactory
□ c. must be thrown away and replaced
□ d. either "a" or "b"

15.8 For studs used in composite construction, the minimum distance from edge of beam flange edge to stud base is:

□ a. $1^1/_2$ inches
□ b. not limited, provided a satisfactory weld is achieved
□ c. the stud diameter plus $^1/_8$ inch
□ d. the thickness of the beam flange

15.9 Arc shields (ferrules) may remain in place prior to concrete placement:

□ a. provided they are slipped up to permit visual inspection
□ b. provided lightweight concrete is used
□ c. provided the studs pass a ring test or bend test
□ d. never

15.10 When the steel to receive the studs is below 32ºF:

□ a. stud welding is not allowed
□ b. all studs shall be bend tested using a pipe rather than a hammer
□ c. one additional stud in 100 must be tested using a 30 degree bend
□ d. one additional stud in 100 must be tested using a 15 degree bend

15.11 Two studs shall be tested by bending them over 30 degrees whenever the following occurs:

□ a. the stud gun lift or plunge is changed
□ b. the power source or welding lead length is changed
□ c. the stud gun current or time is changed more than 5%
□ d. any of the above

15.12 Studs may also be welded by hand, rather than using a stud gun, provided:

□ a. a low-hydrogen process or electrode is used
□ b. the stud base is prepared so that it fits flush with the base metal
□ c. the proper fillet weld size is provided
□ d. all of the above

15.13 Qualification testing for stud welds is required when:

□ a. studs are to be applied to curved or angular surfaces
□ b. studs are to be applied in other than the flat position
□ c. studs are to be applied through metal decking
□ d. any of the above

15.14 Prior to welding for the day or for the shift, two studs are to be welded and visually inspected for 360 degree flash and then bent over approximately:

- □ a. 15 degrees
- □ b. 30 degrees
- □ c. 45 degrees
- □ d. 90 degrees

15.15 In pre-production testing, studs may be accepted if they fail to have 360 degree flash, provided:

- □ a. they pass a 30 degree bend test when struck with a hammer
- □ b. they pass a 45 degree bend test when bent using a pipe or other device placed over the stud
- □ c. they ring solid when struck with a 3-pound sledge hammer
- □ d. none of the above, the studs are rejected

15.16 Individual production studs that fail to exhibit 360 degree flash shall be accepted provided:

- □ a. they pass a 15 degree bend test, bent in the direction opposite of the missing flash
- □ b. they pass a 30 degree bend test, bent in the direction opposite of the missing flash
- □ c. they ring solid when struck with a 3-pound sledge hammer
- □ d. none of the above, the stud must be replaced or manually rewelded

15.17 When a stud weld is deemed unsuitable, it may be:

- □ a. removed and the base metal repaired
- □ b. repaired by welding manually
- □ c. in compression regions, left in place when a good stud is welded adjacent to it
- □ d. any of the above

15.18 To be a qualified welding operator to make stud welds, the person must:

- □ a. successfully weld two consecutive studs and pass the 30 degree bend test and have 360 degree flash
- □ b. successfully weld 10 studs that pass the 90 degree bend qualification test
- □ c. successfully weld two consecutive studs that pass the 15 degree bend test and have 360 degree flash
- □ d. any of the above

15.19 When the temperature of the steel is below what temperature, bend testing shall preferably be done with a pipe or other bending device, in lieu of a hammer strike:

- □ a. 0ºF
- □ b. 32ºF
- □ c. 50ºF
- □ d. 70ºF

15.20 The verification Inspector may perform what type of additional testing of production stud welds:

□ a. 30 degree bend tests
□ b. 15 degree bend tests
□ c. acoustical tests by striking with a hammer
□ d. any of the above

15.21 Following bend testing, studs embedded in concrete shall be:

□ a. straightened to their original position
□ b. left bent
□ c. heated and then straightened to within 5º of their original position
□ d. hand welded to reinforce the stud weld

15.22 In accordance with AISC 360-10, for composite floor construction using steel decks:

□ a. the stud diameter is a maximum of $^3/_4$ inch
□ b. the stud must extend above the top of the deck a minimum of $1^1/_2$ inches
□ c. the top of the concrete slab must be a minimum of $^1/_2$ inch above the top of the stud
□ d. all of the above

15.23 In accordance with AISC 360-10, unless welded directly over the beam web, the maximum diameter of stud permitted when the flange is $^1/_4$-inch thick is:

□ a. $^1/_2$ inch
□ b. $^5/_8$ inch
□ c. $^3/_4$ inch
□ d. 1 inch

15.24 In accordance with AISC 360-10, for composite beams, the minimum length of a $^3/_4$-inch diameter stud is:

□ a. $^3/_4$ inch
□ b. $1^7/_8$ inches
□ c. 2 inches
□ d. 3 inches

15.25 In accordance with AISC 360-10, for composite beams with formed steel decks that span perpendicular to the beam, the minimum spacing of $^3/_4$-inch diameter studs is:

□ a. 6 inches measured along the length of the beam
□ b. 4 inches measured along the length of the beam
□ c. 4 inches measured perpendicular to the length of the beam
□ d. 4 inches measured in any direction

ANSWER KEY	CHAPTER 15 STUD WELDING

REFERENCES

AWS D1.1:2008 Structural Welding Code - Steel, 2008
AWS D1.1:2010 Structural Welding Code - Steel, 2010
Clause 7 - Stud Welding

AISC 360-10 Specification for Structural Steel Buildings, 2010
Chapter I - Design of Composite Members

		AWS D1.1:2008	AWS D1.1:2010
15.1	b	Table 7.1 Notes a & b	Table 7.1 Notes a & b
15.2	b	7.2.3	7.2.3
15.3	d	7.3.3	7.3.3
15.4	c	7.2.5	7.2.5.2
15.5	c	7.4.2	7.4.2
15.6	d	7.4.3	7.4.3
15.7	a	7.4.4	7.4.4
15.8	c	7.4.5	7.4.5
15.9	d	7.4.6	7.4.6
15.10	d	7.5.4	7.5.4
15.11	d	7.7.1.1; 7.7.2; 7.5.4	7.7.1.1; 7.7.2; 7.5.4
15.12	d	7.5.5	7.5.5
15.13	d	7.6.1	7.6.1
15.14	b	7.7.1.1; 7.7.1.3; 7.7.1.4	7.7.1.1; 7.7.1.3; 7.7.1.4
15.15	d	7.7.1.5	7.7.1.5
15.16	a	7.8.1	7.8.1
15.17	d	7.7.3; 7.7.5	7.7.3; 7.7.5
15.18	a	7.7.4	7.7.4
15.19	c	7.7.1.4	7.7.1.4
15.20	b	7.8.2	7.8.2
15.21	b	7.8.3	7.8.3
		AISC 360-10	
15.22	d	Manual Page 16.1-90; AISC 360-10, section I3.2c (1)(c)	
15.23	b	Manual Page 16.1-97; AISC 360-10, section I8.1	
15.24	d	Manual Page 16.1-97; AISC 360-10, section I8.2	
15.25	d	Manual Page 16.1-99; AISC 360-10, section I8.2d	

STUDY GUIDE	CHAPTER 16 SHEET STEEL WELDING

OBJECTIVE

To become familiar with the welding requirements and inspection provisions for structural sheet steels in AWS D1.3 Structural Welding Code - Sheet Steel.

REFERENCE

AWS D1.3:2008 Structural Welding Code - Sheet Steel, 2008

KEY POINTS

AWS D1.3:2008 Structural Welding Code - Sheet Steel, 2008

- To what thickness materials does the AWS D1.3 code apply?
- When sheet steel is welded to structural steel, which specification provisions govern?
- Arc spot welds are limited to what applications? What thicknesses?
- How does the diameter of the weld fusion zone compare to the diameter of the visible spot weld?
- What is the required quality of the steel surface prior to welding?
- What is the required visual weld acceptance criteria for spot welds?
- What is the relationship between welding current and melting rate?
- What WPS qualification testing is required for arc spot welds?
- What WPS qualification testing is required for fillet welds to structural steel?
- What changes in welding procedures require a repeat of qualification testing?
- How is welding personnel qualification testing performed?
- What limits are placed on thickness for welder qualification?
- What limits are placed on steel coating type for welder qualification?
- What inspection tasks are the responsibility of the Inspector?
- What steps are taken if welding is being performed with inadequate melting rates?

QUIZ	CHAPTER 16 SHEET STEEL WELDING

16.1 The AWS D1.3 Structural Welding Code - Sheet Steel is applicable to structural sheet steels:

- □ a. less than $^1/_8$ inch in thickness
- □ b. 0.18 inch and less in thickness
- □ c. $^3/_{16}$ inch and less in thickness
- □ d. 6 gauge and less

16.2 The use of arc spot welds (puddle welds) is limited to welding steels of what thickness to a thicker member?

- □ a. $^1/_{16}$ inch thick and less
- □ b. 0.15 inch and less
- □ c. $^1/_8$ inch thick and less
- □ d. over $^1/_{16}$ inch thick

16.3 An arc seam weld made between sheet steel and a thicker structural member:

- □ a. is made by punching or burning a hole in the sheet steel, then welding
- □ b. is made by welding through the sheet steel
- □ c. may only be made in the flat position
- □ d. both "b" and "c"

16.4 Steels to be welded under the provisions of AWS D1.3 are limited to:

- □ a. 80,000 psi (80 ksi) specified minimum yield point or lower
- □ b. 60,000 psi (60 ksi) specified minimum yield point or lower
- □ c. 33,000 psi (33 ksi) specified minimum tensile strength or lower
- □ d. may be any sheet steel

16.5 When welding sheet steel to thicker supporting members, welding of arc spot and arc seam welds is limited to:

- □ a. the flat and horizontal positions
- □ b. the flat position
- □ c. the horizontal position
- □ d. any position qualified by test

16.6 Weld washers are to be used when welding arc spot welds through sheet steel:

- □ a. 20 gauge and thinner
- □ b. 22 gauge and thicker
- □ c. less than 0.028 inch in thickness
- □ d. less than 0.015 inch in thickness

16.7 The minimum effective diameter of an arc spot weld, measured at the fusion / faying surface, is:

□ a. $^1/_4$ inch
□ b. $^3/_8$ inch
□ c. $^1/_2$ inch
□ d. $^5/_8$ inch

16.8 To achieve a $^1/_2$-inch effective diameter (d_e) arc spot weld (puddle weld) at the fusion (faying) surface, through two layers of sheet steel each $^1/_{16}$-inch thick, the visible diameter (d) of the spot at the surface must be at least:

□ a. $^3/_8$ inch
□ b. $^1/_2$ inch
□ c. $^5/_8$ inch
□ d. 1 inch

16.9 To achieve a $^3/_8$-inch effective diameter arc spot weld (puddle weld) through a single layer of 22 gauge (0.0299 inch) deck, the visible diameter, rounded to the nearest $^1/_{16}$ inch, of the spot weld at the surface must be at least:

□ a. $^3/_8$ inch
□ b. $^1/_2$ inch
□ c. $^5/_8$ inch
□ d. $^3/_4$ inch

16.10 The minimum length of weld when using fillet, flare-bevel groove or flare-V groove welds is:

□ a. twice the thickness of the material
□ b. twice the radius of the material
□ c. equal to four times the weld size
□ d. $^3/_4$ inch

16.11 The visual weld acceptance criteria for an arc spot weld is:

□ a. minimum reinforcement of $^1/_{32}$ inch
□ b. cumulative undercut no longer than one-eighth the spot weld circumference
□ c. no cracks
□ d. all of the above

16.12 When welding sheet steel to an ASTM A572 Grade 65 plate over $^1/_4$-inch thickness:

□ a. low-hydrogen electrodes must be used in accordance with AWS D1.1
□ b. low-hydrogen electrodes are optional, even though required by AWS D1.1
□ c. low-hydrogen electrodes must be used as required by AWS D1.1, except storage requirements and exposure limits are waived
□ d. E70 electrodes must be used

16.13 A Procedure Qualification Record (PQR) written for welding on a steel with a coating 1.0 mil in thickness is valid for steels with a coating thickness of:

□ a. 1.0 mil, +/- 10%
□ b. up to 1.0 mil
□ c. up to 1.3 mils
□ d. up to 2.0 mils

16.14 A PQR written for an arc spot weld using E7024 electrodes through a single thickness of sheet steel of 16 gauge (0.0598 inch) is valid for the following thickness range:

□ a. 16 gauge only
□ b. 16 gauge and thicker
□ c. 16 gauge and thinner
□ d. 0.0538 inch through 0.0658 inch thickness

16.15 The Inspector may request that the electrode melting rate is measured during welding. Should the melting rate or current be 5 percent or more below that specified, then:

□ a. the welder must requalify
□ b. proper welds must be placed adjacent to those made with inadequate current
□ c. the welds are acceptable if appearance is acceptable
□ d. the weld puddle must be enlarged by 5%

16.16 Developing a PQR for an arc spot weld includes:

□ a. visual inspection
□ b. torsional shearing (twisting) of the weld using a hammer on the sheet steel
□ c. measurement of the remaining weld nugget
□ d. all of the above

16.17 A welder qualified to make arc spot welds by testing on 22 gauge (0.0299 inch) material is qualified to weld:

□ a. 22 gauge material
□ b. 22 gauge material and thicker
□ c. 22 gauge material and thinner
□ d. between 16 gauge (0.0598 inch) and 28 gauge (0.0149 inch)

16.18 A welder qualified by testing on plain, uncoated sheet steel is qualified to weld on what type(s) of material?

□ a. plain, uncoated steel
□ b. galvanized steel
□ c. painted steel
□ d. all of the above

16.19 The thickness of a 14 gauge uncoated cold-rolled sheet steel is:

- □ a. 0.014 inch
- □ b. $^1/_{16}$ inch
- □ c. 0.0747 inch
- □ d. 0.14 inch

16.20 A welder qualified by testing on galvanized sheet steel is qualified to weld on:

- □ a. painted steel
- □ b. uncoated steel
- □ c. neither painted steel or uncoated steel
- □ d. both painted steel and uncoated steel

16.21 Which SMAW matching filler metal is acceptable when welding ASTM A1011/A1011M SS Grade 36 Type 2 steel?

- □ a. E60XX
- □ b. E70XX-X
- □ c. E80XX-X
- □ d. any of the above

ANSWER KEY	CHAPTER 16 SHEET STEEL WELDING

REFERENCE

AWS D1.3:2008 Structural Welding Code - Sheet Steel, 2008

		AWS D1.3: 2008
16.1	c	1.1
16.2	b	1.5.4
16.3	d	1.5.5
16.4	a	1.2.3
16.5	b	1.5.4; 1.5.5 (2); Table 1.3
16.6	c	2.3.5.3
16.7	b	2.2.4; 2.3.5.1
16.8	d	Figure 2.4(B)
16.9	c	Figure 2.4(A)
16.10	d	2.3.3.1 (fillet); 2.3.4.1 (flare-bevel); 2.3.4.2 (groove)
16.11	d	6.1.1,
16.12	a	1.4.4.2; Table 1.2, note 1; Annex A, Table A.1 (Clause 5)
16.13	c	Table 4.2(13)
16.14	d	Table 4.2(10)(a)
16.15	b	6.3.1
16.16	d	4.6.4.2 (3) and (4); Figure 4.4
16.17	a	4.7.2 (1); 4.8.1.2; Table 4.4 (Figure 4.4)
16.18	a	4.7.1.1
16.19	c	Annex E, Table E.1
16.20	b	4.7.1.1; 4.8.1.2
16.21	c	Table 1.2 (Group III)

STUDY GUIDE	CHAPTER 17 REINFORCING STEEL WELDING

OBJECTIVE

To become familiar with the welding requirements and inspection provisions for reinforcing steel in the AWS D1.4 Structural Welding Code - Reinforcing Steel.

REFERENCE

AWS D1.4:2005 Structural Welding Code - Reinforcing Steel, 2005
AWS D1.4:2011 Structural Welding Code - Reinforcing Steel, 2011

KEY POINTS

AWS D1.4:2005 Structural Welding Code - Reinforcing Steel, 2005
AWS D1.4:2011 Structural Welding Code - Reinforcing Steel, 2011

- What reinforcing steels are covered under the AWS D1.4 code?
- How is the carbon equivalent calculated for ASTM A706 steel? For other steels?
- If the steel chemistry is not known, what preheat is required?
- What are lap joints, direct butt joints, and indirect butt joints?
- How is a direct butt joint between two different diameters of reinforcing steel made?
- What limits are applicable to welded lap joints?
- When should split pipe backing be used in direct butt joints?
- Become familiar with the organization of Figures 3.1 through 3.5.
- What eccentricity between bars in direct butt joints is permitted?
- What separation between bars is permitted for indirect butt joints? For indirect lap joints?
- Is the welding of crossed bars permitted?
- What visual weld quality is required?
- When should the welding of reinforcing steel not be performed?
- Are tack welds permitted?
- How is welding accomplished on galvanized bars? On epoxy-coated bars?
- Become familiar with the organization of Table 5.1 for matching filler metals.
- Become familiar with the organization of Table 5.2 for minimum preheat and interpass temperatures.
- For what time period may SMAW low-hydrogen electrodes be held outside the rod storage oven?
- What changes to a WPS require requalification testing?
- What changes to rebar would require requalification of a welder?
- What are the responsibilities of a welding Inspector regarding reinforcing steel?

QUIZ	CHAPTER 17 REINFORCING STEEL WELDING

17.1 ASTM A615 Grade 40 reinforcing steel is being used. The mill test report states the carbon content is 0.25 and the manganese content is 1.2. The Carbon Equivalent (CE) value is:

- □ a. 0.25%
- □ b. 0.37%
- □ c. 0.45%
- □ d. 1.45%

17.2 ASTM A706 reinforcing steel of 1-inch [25 mm] diameter is used with the following mill test report: 0.25 carbon, 0.90 manganese, 0.40 copper, 0.40 nickel, 0.50 chromium, 0.50 molybdenum, and 0.10 vanadium. Calculate the Carbon Equivalent.

.

- □ a. 0.40
- □ b. 0.46
- □ c. 0.50
- □ d. 0.57

17.3 No mill test reports are available. An ASTM A615 number 8 [25] reinforcing steel bar is being welded to an ASTM A706 number 6 [19] bar. What is the required minimum preheat temperature?

- □ a. no preheat required unless the steel is below 32º
- □ b. 100ºF
- □ c. 300ºF
- □ d. 500ºF

17.4 An ASTM A706 number 18 [57] reinforcing steel bar with a CE of .50 is being welded using SMAW, low-hydrogen electrodes to an ASTM A572 Grade 50 plate that is $2^{3}/_{4}$ inches thick. Using AWS D1.1 and AWS D1.4 criteria, what is the minimum preheat required?

- □ a. 400ºF
- □ b. 200ºF
- □ c. 225ºF
- □ d. 300ºF

17.5 An indirect lap joint is being used to join a number 4 [13] reinforcing steel bar to a number 6 [19] bar. What is the minimum effective weld length that should be used for the weld on the number 6 [19] bar?

- □ a. $^{1}/_{2}$ inch
- □ b. $^{3}/_{4}$ inch
- □ c. 1 inch
- □ d. $1^{1}/_{2}$ inches

17.6 A number 8 [25] reinforcing steel bar is being welded to a number 11 [36] bar in a direct butt tension splice. The bars are axially aligned. The type of weld required is a:

□ a. single bevel groove
□ b. single bevel groove with fillet reinforcement
□ c. double bevel groove with fillet reinforcement
□ d. double flare bevel groove

17.7 Two number 8 [25] reinforcing steel bars are being joined using a lap joint. This type of joint:

□ a. requires a flare-V groove weld
□ b. requires a double flare-V groove weld
□ c. requires the use of a separator bar and flare-V grooves
□ d. is prohibited

17.8 Two number 6 [19] reinforcing steel bars positioned on a horizontal axis are being welded for a direct butt joint. Which joint detail is acceptable?

□ a. single-V groove, 45 degree to 60 degree groove angle, 0 inch to $^1/_8$ inch root opening
□ b. double-V groove, 45 degree to 60 degree groove angle, 0 inch to $^1/_8$ inch root face, and 0 inch to $^1/_8$ inch root opening
□ c. single-V groove with split pipe backing, 55 degree to 70 degree groove angle and root opening $^1/_8$ inch to $^5/_{32}$ inch
□ d. any of the above

17.9 A direct butt joint between two number 14 [43] reinforcing steel bars may not align exactly. The permitted out-of-alignment offset is:

□ a. $^1/_8$ inch
□ b. $^3/_{16}$ inch
□ c. $^1/_4$ inch
□ d. 10 degrees

17.10 An indirect butt joint is being used for splicing two number 5 [16] reinforcing steel bars. A splice plate is used. The maximum distance between the ends of the bars is:

□ a. $^1/_8$ inch
□ b. 1.25 times the bar diameter, but not more than $^3/_{16}$ inch
□ c. $^3/_4$ inch
□ d. not limited

17.11 Two number 4 [13] reinforcing steel bars intersect at 90º angles to one another. A weld between these two bars:

□ a. is prohibited
□ b. cannot exceed $^1/_4$-inch effective throat
□ c. is prohibited unless authorized by the Engineer
□ d. is permitted for tacking bars in place only

17.12 When welding on reinforcing steel bars or other components already embedded in concrete:

□ a. no preheat is allowed
□ b. allowance shall be made for thermal expansion of the steel
□ c. welding procedures shall be followed using the lowest heat input possible
□ d. some concrete spalling is expected and acceptable

17.13 When making lap joints or butt joints, undercut:

□ a. is not permitted in the solid bar, but is permitted in the deformations
□ b. cannot exceed the height of the deformation
□ c. cannot exceed $^1/_{32}$ inch into the solid bar
□ d. cannot exceed $^1/_{16}$ inch for bar sizes up to and including number 8, and cannot exceed $^1/_8$ inch for bars larger than number 8

17.14 A number 7 [22] reinforcing steel bar with CE=0.56 is being welded to a number 6 [19] bar with CE=0.67. The required preheat and interpass temperature is:

□ a. 100ºF
□ b. 200ºF
□ c. 300ºF
□ d. 400ºF

17.15 Tack welds:

□ a. may be made without preheat if welded over with a finished weld
□ b. are prohibited unless authorized by the Engineer
□ c. may contain weld defects as long as they are remelted by the final weld
□ d. need not be inspected prior to final welding

17.16 When welding epoxy-coated reinforcing steel:

□ a. the coating must be removed for flare groove welds, but is acceptable for groove welds when the ends are trimmed
□ b. shall be reduced in thickness with a wire brush
□ c. shall be completely removed from the heated area
□ d. need not be removed if a suitable welding procedure is followed

17.17 When splicing number 9 [29] or larger ASTM A706 Grade 60 reinforcing steel bars, the following SMAW low-alloy steel electrodes are permitted:

□ a. E7018-X with additional preheat of 300ºF
□ b. E8015-X, E8016-X or E8018-X
□ c. ER80S
□ d. E9015-X, E9016-X or E9018-X

17.18 When welding ASTM A615 Grade 60 reinforcing steel bars to ASTM A615 Grade 40 bars, the following SMAW electrodes are permitted:

□ a. E70XX
□ b. E7015, E7016, E7018, E7028
□ c. E8015, E8016 or E8018
□ d. E9015, E9016 or E9018

17.19 ASTM A615 reinforcing steel is being welded but is of unknown composition. For number 8 [25] bars:

□ a. a minimum preheat of 400ºF is required
□ b. a minimum preheat of 500ºF is required
□ c. compositional testing is required prior to welding
□ d. a Carbon Equivalent of 0.65 is assumed

17.20 ASTM A615 Grade 75 reinforcing steel bars are being welded using E10015-X SMAW electrodes. The humidity conditions are not known. The maximum time outside the electrode storage oven, or from the original hermetically sealed container, is:

□ a. 4 hours
□ b. between $^1/_2$ hours and 4 hours
□ c. $^1/_2$ hour
□ d. not limited

17.21 Written welding procedures are:

□ a. required for all field welding only
□ b. required for all shop and field welding
□ c. not required if the welder has experience in making similar welds
□ d. not required unless welding to structural steel

17.22 The following joint types are considered prequalified, and therefore no procedure qualification records are required for documentation of the welding procedure specification:

□ a. partial joint penetration groove welds
□ b. complete joint penetration groove welds
□ c. fillet welds
□ d. flare-bevel and flare-V groove welds

17.23 Welding procedure qualification testing:

□ a. must use the average bar size and average CE to be used in production
□ b. must use the maximum bar size and maximum CE to be used in production
□ c. is not required for ASTM A706 bars
□ d. is not required if the required preheat is provided

17.24 Welding procedures must be requalified if:

- □ a. there is an increase in the electrode diameter
- □ b. there is an increase in the filler metal classification strength
- □ c. there is a change in the groove type
- □ d. any of the above

17.25 A welder qualified to perform SMAW on uncoated ASTM A706 Grade 60 steel:

- □ a. must be requalified if welding on other stronger steels
- □ b. must be requalified if preheat is reduced more than 25ºF
- □ c. must be requalified if using a higher strength electrode
- □ d. must be requalified if welding galvanized reinforcing steel

17.26 Welders qualified to make complete penetration groove welds in direct butt joints:

- □ a. are not qualified to perform flare-bevel or flare-V groove welds
- □ b. are qualified to perform any structural welding on reinforcing steel
- □ c. may also weld indirect butt joints
- □ d. must be requalified to perform fillet welds

17.27 When performing welder qualification tests:

- □ a. the bar size used for testing qualifies the welder for that bar size and smaller
- □ b. the bar size used for testing qualifies the welder for that bar size and larger
- □ c. the bar size used for testing qualifies the welder for only that bar size
- □ d. the bar size need not be noted and is not limited by the test bar size

17.28 A welder's qualification is revoked or expires:

- □ a. six months after taking the qualification test
- □ b. if the welder fails to weld using that process within the past six months
- □ c. if there are reasons to question the welder's ability
- □ d. either "b" or "c"

17.29 Inspectors shall be notified:

- □ a. prior to the commencement of welding operations
- □ b. that welding is underway
- □ c. upon completion of the welding of the joint
- □ d. prior to encasement of the reinforcing steel by the concrete

17.30 The Inspector's list of duties includes:

- □ a. confirming that the welds conform to the requirements of the detail drawings
- □ b. confirming that no unspecified welds have been made
- □ c. observing, at suitable intervals, the technique of each welder
- □ d. all of the above

17.31 Where reinforcing steel bars have been cold bent, no welding is permitted:

- □ a. on the cold bent portion
- □ b. within 2 inches of the cold bent portion
- □ c. on the cold bent portion, and within 2 bar diameters of the cold bent portion
- □ d. until the cold bent portion has been preheated to a minimum 300ºF

17.32 The nominal diameter of a number 11 [36] reinforcing bar is:

- □ a. $1\frac{3}{8}$ inches
- □ b. $\frac{11}{36}$ inch
- □ c. 1.410 inches
- □ d. 1.560 inches

17.33 The Inspector's list of duties includes:

- □ a. checking that WPSs are available to the welders
- □ b. verifying the accuracy of all WPSs
- □ c. stamping their approval on each WPS prior to use
- □ d. all of the above

17.34 The maximum reinforcement height permitted on a groove weld is:

- □ a. $\frac{1}{16}$ inch
- □ b. $\frac{1}{8}$ inch
- □ c. 0.07 times the bar diameter
- □ d. unlimited

ANSWER KEY	CHAPTER 17 REINFORCING STEEL

REFERENCE

AWS D1.4:2005 Structural Welding Code - Reinforcing Steel, 2005
AWS D1.4:2011 Structural Welding Code - Reinforcing Steel, 2011

		AWS D1.4:2005	AWS D1.4:2011
17.1	c	1.3.4.1	1.3.4.1
17.2	c	1.3.4.2	1.3.4.2
17.3	d	1.3.4.3 (2); Table 5.2, note 4	1.3.4.4; Table 5.2, note d
17.4	c	AWS D1.4 Table 5.2; AWS D1.1 Table 3.2 (governs)	AWS D1.4 Table 5.2; AWS D1.1 Table 3.2 (governs)
17.5	d	Figure 3.4(B)	Figure 3.4(B)
17.6	c	3.1; Figure 3.1	3.1; Figure 3.1
17.7	d	3.2.2	3.2.2
17.8	d	3.4; Table 3.1; Figure 3.2	3.4; Table 3.1; Figure 3.2
17.9	b	4.2.1	4.2.1
17.10	c	4.2.2; Figure 3.3(A)	4.2.2; Figure 3.3(A)
17.11	c	4.2.5	4.2.5
17.12	b	4.3.2	4.3.2
17.13	c	4.4.6	4.4.6
17.14	c	5.2.1; Table 5.2	5.2.1; Table 5.2
17.15	b	5.5	5.6
17.16	c	5.7.4	5.8.3
17.17	b	5.1.1; Table 5.1 (Group II)	5.1.1; Table 5.1 (Group II)
17.18	b	5.1.1; 5.1.2, Table 5.1 (Group I)	5.1.1; 5.1.2; Table 5.1 (Group I)
17.19	b	1.3.4.3 (2); Table 5.2	1.3.4.4; Table 5.2
17.20	c	5.8.2; Table 5.3 (Column A)	5.9.2; Table 5.3 (Column A)
17.21	b	6.1.1.1	6.1.1.1
17.22	c	6.1.2.1	6.1.2.1; Table 6.1 (added 2011)
17.23	b	6.2.1.1; 6.2.1.2	6.2.1.1; 6.2.1.2
17.24	d	6.2.1.4; Table 6.1(1), (3) and (11)	6.2.1.4; Table 6.2(1), (3) and (11)
17.25	d	6.3.2.1	6.3.2.1

		AWS D1.4:2005	AWS D1.4:2011
17.26	a	6.3.3.1 (1); Table 6.3	6.3.4.1; Table 6.4
17.27	b	6.3.2.2	6.3.2.2
17.28	d	6.5	6.5
17.29	a	7.1.4	7.1.4
17.30	d	7.5.1; 7.5.4	7.5.1; 7.5.4
17.31	c	4.2.6; Figure 4.2	4.2.6; Figure 4.1
17.32	c	Annex B	Annex B
17.33	a	7.5.3	7.5.3
17.34	b	Figure 4.1(D)	Figure 4.2(D)

STUDY GUIDE	CHAPTER 18 WELDING SYMBOLS

OBJECTIVE

To become familiar with the use of symbols for structural welding and nondestructive testing.

REFERENCES

AWS A2.4:2007 Standard Symbols for Welding, Brazing and Nondestructive Examination, 2007

Clause 3 Basic Welding Symbols
Clause 4 Joint Types
Clause 5 General Provisions for Welding Symbols
Clause 6 Groove Welds
Clause 7 Fillet Welds
Clause 16 Nondestructive Examination Symbols

AWS A2.4:2012 Standard Symbols for Welding, Brazing and Nondestructive Examination, 2012

Clause 4 Basic Welding Symbols
Clause 5 Joint Types
Clause 6 General Provisions for Welding Symbols
Clause 7 Groove Welds
Clause 8 Fillet Welds
Clause 17 Nondestructive Examination Symbols

KEY POINTS

AWS A2.4 Standard Symbols for Welding, Brazing and Nondestructive Examination

Clause 3 Basic Welding Symbols & Clause 5 General Provisions for Welding Symbols (2007)
Clause 4 Basic Welding Symbols & Clause 6 General Provisions for Welding Symbols (2012)

- What is the reference line?
- Which is the arrow side and the other side?
- What symbols are used for the following welds?
- – fillet
- – square groove
- – V groove and bevel groove
- – J groove and U groove
- – flare bevel groove and flare V groove
- – plug / slot
- – spot
- – seam
- What symbol is used to indicate weld all around?
- How is the sequence of operations shown?
- How is field welding designated?
- What type of information is provided in the tail?
- What are the contour symbols?
- What are the finishing symbols?
- How is stitch (intermittent) welding shown?

Clause 6 Groove Welds & Clause 7 Fillet Welds (2007)
Clause 7 Groove Welds & Clause 8 Fillet Welds (2012)

- How and where is weld size and length shown?
- How is the effective throat and depth of preparation for a Partial Joint Penetration (PJP) groove weld shown?
- How is the root opening shown?
- How is the groove angle shown?
- How is a backing weld or back weld shown?
- How is the part to receive joint preparation designated?
- How is backing shown
- How is a spacer shown?

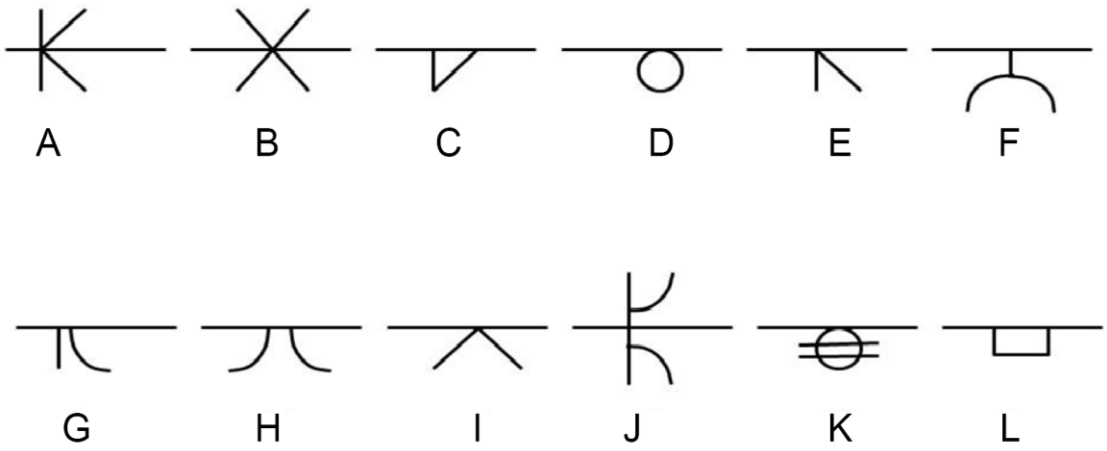
Clause 16 Nondestructive Examination Symbols (2007)
Clause 17 Nondestructive Examination Symbols (2012)

- What abbreviations are used for the various nondestructive examination processes?
- How is nondestructive examination (NDE) designated?
- How is the direction of radiation for a radiograph shown?
- How is the side from which examination is made designated?
- How is the length of examination shown?
- How is the number or percentage of examinations shown?

QUIZ	CHAPTER 18 WELDING SYMBOLS

18.1 Match the symbols below with the type of weld:

fillet weld	_____
single bevel groove weld	_____
plug weld	_____
double bevel groove weld	_____
single V groove weld	_____
flare bevel groove weld	_____
flare V groove weld	_____
double J groove weld	_____
single U groove weld	_____
spot weld	_____
seam weld	_____
double V groove weld	_____



18.2 When a box appears opposite a groove weld symbol, this indicates:

□ a. a plug weld is required on the side opposite the groove weld
□ b. backing is to be used
□ c. the bottom of the weld is to be reinforced
□ d. a rectangular filler is needed at the root

18.3 When the reference line contains a box from which groove weld symbols are shown:

□ a. a filler is needed at the root of the joint
□ b. a spacer is used at the root, to be removed by backgouging prior to welding the second side
□ c. a wider root opening than standard is to be used
□ d. the root face is to be square

18.4 A flag appearing at the intersection of reference line and arrow line indicates:

□ a. this is an important weld
□ b. nondestructive testing of this weld is required
□ c. visual inspection of this weld is required at the time of welding
□ d. welding is to be done in the field

18.5 The size of a fillet weld always appears:

□ a. to the arrow line side of the fillet weld symbol
□ b. to the left of the symbol
□ c. to either side of the symbol, as long as length need not be noted
□ d. on the opposite side of the reference line from the symbol

18.6 The required size (throat) of a partial joint penetration groove weld is shown:

□ a. to the left of the symbol, placed in parentheses
□ b. to the left of the symbol and to the left of the depth of preparation required
□ c. opposite the weld symbol
□ d. in the tail of the reference line

18.7 A straight line across the face of a groove weld symbol, with no additional letters, indicates:

□ a. weld the surface as flat as possible
□ b. machine the surface smooth
□ c. grind the surface smooth
□ d. both "a" and "c"

18.8 The notation "3-12" to the right of a fillet weld symbol indicates:

□ a. weld size is $^{3}/_{12}$ inch, or $^{1}/_{4}$ inch
□ b. a 3-inch fillet weld that is 12 inches long
□ c. a series of fillet welds 3 inches long with 12-inch gaps between them
□ d. a series of fillet welds 3 inches long located 12 inches center to center

18.9 When the arrow line is bent (has a break) and points to a particular side of the joint of a bevel or J groove weld, this indicates:

□ a. nothing in particular
□ b. prepare the side of the joint being pointed to
□ c. put the weld on the other side of the joint, rather than the arrow side
□ d. the joint is skewed

18.10 When there are multiple reference lines coming off the arrow line, this indicates:

- □ a. there are several types of welds that are acceptable for this joint, and use one of those shown
- □ b. several steps are needed, make the weld furthest away from the arrow first, then proceed in sequence with those steps shown closer to the arrow
- □ c. several steps are needed, make the weld closest to the arrow first, then proceed in sequence with those steps shown progressing outward from the arrow
- □ d. a different weld process is needed for different welds

18.11 An empty circle shown at the intersection of the arrow line and the reference line indicates:

- □ a. a field weld is to be made
- □ b. a shop weld is to be made
- □ c. this is a critical weld
- □ d. weld the joint all around

18.12 A circle with an "X" placed inside is the symbol for what type of weld:

- □ a. a spot weld that must be removed
- □ b. no welding permitted in this area
- □ c. a stud weld made with an automatic stud-welding gun
- □ d. do not weld all around the joint

18.13 The number $^1/_8$ placed above or below a groove weld symbol indicates:

- □ a. the specified root opening is $^1/_8$ inch
- □ b. the specified effective throat is $^1/_8$ inch
- □ c. increase the depth of preparation $^1/_8$ inch greater than the size specified
- □ d. provide $^1/_8$ inch reinforcement

18.14 The side that the welding symbol arrow points to is called the arrow side, and the symbol for the arrow-side weld is placed:

- □ a. on top of the reference line
- □ b. below the reference line
- □ c. on either side of the reference line, as convenient
- □ d. in the tail of the reference line

ANSWER KEY	CHAPTER 18 WELDING SYMBOLS

REFERENCES

AWS A2.4:2007 Standard Symbols for Welding, Brazing and Nondestructive Examination, 2007

AWS A2.4:2012 Standard Symbols for Welding, Brazing and Nondestructive Examination, 2012

			AWS A2.4:2007	AWS A2.4:2012
18.1	C E L A I G H J F D K B	fillet weld single bevel groove weld plug weld double bevel groove weld single V groove weld flare bevel groove weld flare V groove weld double J groove weld single U groove weld spot weld seam weld double V groove weld	Figure 1	Figure 1
18.2	b		6.8	7.8
18.3	b		6.9	7.9
18.4	d		5.8	6.8
18.5	b		7.2	8.2
18.6	a		6.2.1	7.2.1
18.7	a		6.6.1	7.6.1
18.8	d		7.4.3	8.4.3
18.9	b		6.1.3.1	7.1.3.1
18.10	c		5.7.1	6.7.1
18.11	d		Figure 2	Figure 2
18.12	c		Figure 1	Figure 1
18.13	a		6.3.1	7.3.1
18.14	b		5.1	6.1

STUDY GUIDE	CHAPTER 19 STEEL JOISTS AND JOIST GIRDERS

OBJECTIVE

To become familiar with the quality and installation requirements for the fabrication and erection of open web steel joists, longspan and deep longspan steel joists, and steel joist girders.

REFERENCES

Standard Specifications and Load and Weight Tables for Steel Joists and Joist Girders, 43rd Edition, including:

- SJI-K-2010, Standard Specifications for Open Web Steel Joists, K Series
- SJI-LH/DLH-2010, Standard Specifications for Longspan Steel Joists, LH-Series and Deep Longspan Steel Joists, DLH-Series
- SJI-JG-2010, Standard Specifications for Joist Girders
- SJI-CJ-2010, Standard Specifications for Composite Steel Joists, CJ-Series
- SJI-COSP-2010, Code of Standard Practice for Steel Joists and Joists Girders
- SJI-CJCOSP-2010, Code of Standard Practice for Composite Steel Joists

KEY POINTS

Standard Specifications and Load and Weight Tables for Steel Joists and Joist Girders, 43rd Edition

- What inspection is performed of joist and joist girder manufacturers?
- What inspection is performed on joist and joist girder welds?
- What is the required quality level for joist and joist girder welds?
- What are the required bearing lengths at the ends of joists? Longspan joists? Joist girders?
- What is the minimum attachment for connections at the ends of joists? Longspan joists? Joist girders?
- What are the bridging requirements for various K-series joists? Longspan joists?
- What are the bracing requirements for joist girders?
- What is the minimum spacing of top chord attachments to joists and longspan joists?

QUIZ	CHAPTER 19 STEEL JOISTS AND JOIST GIRDERS

19.1 Weld quality is verified by the manufacturer:

- □ a. visually, 100% of all welds
- □ b. visually, on selected welds only
- □ c. in accordance with AWS D1.1 requirements
- □ d. using magnetic particle methods

19.2 Cracks in welds are:

- □ a. acceptable if they run along the length of the weld
- □ b. acceptable if less than $^1/_4$ inch in length
- □ c. not acceptable
- □ d. may be left in place if additional welding is placed

19.3 Undercut along the toe of a weld is:

- □ a. acceptable if $^1/_{16}$ inch or less in depth and oriented parallel to the principal stress
- □ b. unacceptable if oriented perpendicular to the principal stress
- □ c. unacceptable if more than $^1/_{32}$ inch in depth
- □ d. both "a" and "b"

19.4 Shop splices in joist and joist girder webs and chords:

- □ a. are not limited in location
- □ b. are allowed only in the middle third of the member's length
- □ c. are permitted in webs, but not permitted in chords
- □ d. are prohibited

19.5 Manufacturers of joists and joist girders shall have their plant inspected:

- □ a. by a testing agency specified by the Building Official
- □ b. by a testing agency approved by the purchaser of the joists
- □ c. by a testing agency approved by the Steel Joist Institute
- □ d. at least annually by an independent testing agency

19.6 When a K-Series steel bar joist rests on a steel beam flange, the minimum length of bearing of joist seat on the steel beam is:

- □ a. 1 inch
- □ b. 2 inches
- □ c. $2^1/_2$ inches
- □ d. 4 inches

19.7 When a K-Series steel bar joist rests on a masonry wall, the connection requires:

□ a. 4 inches of bearing resting directly on grouted masonry
□ b. use of a government anchor
□ c. a steel bearing plate, with the joist end at least 4 inches over the masonry
□ d. a concrete lintel

19.8 An 18K6 joist spans 30 feet, with no uplift forces. What bridging is required?

□ a. two rows, any type, minimum
□ b. three rows, any type, minimum
□ c. three rows, two horizontal and the one center row diagonal
□ d. four rows, minimum

19.9 A 22K5 joist spans 40 feet. What bridging is required?

□ a. three rows, any type
□ b. three rows, with the center row bolted diagonal
□ c. three rows, all bolted diagonal
□ d. four rows, with a center row bolted diagonal

19.10 28K5 joists are spaced at 6 feet,-8 inches on center. What is the minimum size horizontal bridging acceptable?

□ a. $^{5}/_{8}$-inch round
□ b. L $1^{1}/_{4}$ x $1^{1}/_{4}$ x $^{7}/_{64}$
□ c. L $1^{1}/_{2}$ x $1^{1}/_{2}$ x $^{7}/_{64}$
□ d. L 2 x 2 x $^{1}/_{8}$

19.11 A K-Series joist resting on a steel beam or bearing plate may be attached using:

□ a. two tack welds of adequate quality
□ b. two fillet welds, minimum $^{1}/_{8}$ inch in size and 2 inches long
□ c. two ASTM A307 bolts, $^{1}/_{2}$ inch in diameter
□ d. either "b" or "c"

19.12 The maximum spacing of welds or screws anchoring deck to K-Series, LH-Series and DLH-Series steel members to meet the joist design requirements is:

□ a. 12 inches
□ b. 18 inches
□ c. 36 inches
□ d. at least one at the midpoint of each panel point

19.13 A 48LH16 joist spans 60 feet, without uplift. The required bridging is:

□ a. two rows, all horizontal
□ b. two rows, all bolted diagonal
□ c. three rows, two horizontal and one row bolted diagonal nearest center
□ d. four rows bolted diagonal bridging

19.14 A 60DLH15 joist rests on a steel seat attached to a column. The minimum length of bearing of the joist on the seat is:

□ a. $2^1/_2$ inches
□ b. 4 inches
□ c. 6 inches
□ d. 9 inches

19.15 A group of 72DLH16 joists are spaced at 10 feet on center. What is the minimum size bolted diagonal bridging?

□ a. L $2^1/_2$ x $2^1/_2$ x $^5/_{32}$
□ b. L $1^3/_4$ x $1^3/_4$ x $^7/_{64}$
□ c. L 2 x 2 x $^1/_8$
□ d. L $1^1/_2$ x $1^1/_2$ x $^7/_{64}$

19.16 For K-series joists, LH and DLH joists, and joist girders:

□ a. weld piping porosity cannot exceed $^1/_8$ inch in size
□ b. the sum of weld piping porosity diameters cannot exceed $^1/_{16}$ inch in any 1 inch of design weld length
□ c. weld piping porosity is unlimited
□ d. the sum of weld piping porosity diameters cannot exceed $^3/_8$ inch in any inch of weld length, nor 1 inch in any 12 inches weld length

ANSWER KEY	CHAPTER 19 STEEL JOISTS AND JOIST GIRDERS

REFERENCES

Standard Specifications and Load and Weight Tables for Steel Joists and Joist Girders, 43rd Edition, including:

- SJI-K-2010, Standard Specifications for Open Web Steel Joists, K Series
- SJI-LH/DLH-2010, Standard Specifications for Longspan Steel Joists, LH-Series and Deep Longspan Steel Joists, DLH-Series
- SJI-JG-2010, Standard Specifications for Joist Girders
- SJI-CJ-2010, Standard Specifications for Composite Steel Joists, CJ-Series
- SJI-COSP-2010, Code of Standard Practice for Steel Joists and Joists Girders
- SJI-CJCOSP-2010, Code of Standard Practice for Composite Steel Joists

		SJI-K-2010	SJI-LH/DLH-2010	SJI-JG-2010	COSP-2010
19.1	b	4.5(a)(1)(a)	103.5(a)(1)(a)	1003.5(a)(1)(a)	---
19.2	c	4.5(a)(1)(b)	103.5(a)(1)(b)	1003.5(a)(1)(b)	---
19.3	d	4.5(a)(1)(e)	103.5(a)(1)(e)	1003.5(a)(1)(e)	---
19.4	a	4.5(b)(2)	103.5(b)(2)	1003.5(b)(2)	---
19.5	c	4.7(d)	103.7(b)	1003.7(b)	---
19.6	c	5.3(b)	---	---	---
19.7	c	5.3(a)	---	---	---
19.8	a	5.4(c); Table 5.4-1; 6(a)(3) with Standard Load Table (no shading)	---	---	---
19.9	b	5.4(c); Table 5.4-1; 6(a)(3) with Standard Load Table (red shading)	---	---	---
19.10	c	---	---	---	2.7(b); Table 2.7-1a

		SJI-K-2010	SJI-LH/DLH-2010	SJI-JG-2010	COSP-2010
19.11	d	5.6(a); 5.6(b)	---	---	---
19.12	c	5.8(e)	104.9(e)	---	---
19.13	b	---	104.5(c); 104.5(d); Table 104.5-1 and Standard Load Table (no shading)	---	---
19.14	b	---	104.4(b); Table 104.4-1	---	---
19.15	b	---	---	---	2.7(c); Table 2.7-2
19.16	b	4.5(a)(1)(f)	103.5(a)(1)(f)	1003.5(a)(1)(f)	---

STUDY GUIDE	CHAPTER 20 STEEL FLOOR AND ROOF DECKS

OBJECTIVE

To become familiar with the requirements for the quality, placement, attachment and inspection of steel composite floor decks, steel non-composite floor decks, and steel roof decks.

REFERENCES

ANSI/SDI C-2011, Standard for Composite Steel Floor Deck – Slabs, 2011

ANSI/SDI NC-2010, Standard for Non-Composite Steel Floor Deck, 2010

ANSI/SDI RD-2010, Standard for Steel Roof Deck, 2010

ANSI/SDI QA/QC-2011, Standard for Quality Control and Quality Assurance for Installation of Steel Deck, 2011

COSP14, SDI Code of Standard Practice 2014, 2014

KEY POINTS

- What are the manufacturing tolerances for decks?
- What are the nominal thickness values for decks?
- When are mid-span side-lap attachments required?
- What is the maximum distance between mid-span side-lap attachments?
- What are the attachment requirements along perimeter edges of deck?
- What welding specification governs the welding of steel decks?
- What minimum size welds are required for attaching deck to supporting steel?
- At what locations are composite floor decks to be attached to the supporting steel?
- At what locations are noncomposite floor decks to be attached to the supporting steel?
- At what locations are roof decks to be attached to the supporting steel?
- When are welding washers to be used?
- What minimum cover of concrete is required above composite steel floor deck?
- What minimum cover of concrete is required above noncomposite steel floor deck?
- What should the deck condition be before pouring the concrete slab?
- What documents are required to be available for steel deck attached by welding? For attachment using mechanical fasteners?
- What inspection functions does the Quality Assurance Inspector perform for welded deck? For mechanically fastened deck?

QUIZ	CHAPTER 20 STEEL FLOOR AND ROOF DECKS

20.1 The length tolerance for steel deck to be butted is:

□ a. plus / minus 1 inch
□ b. plus / minus 1/2 inch
□ c. plus / minus 1/4 inch, unless gaps are taped
□ d. no specified tolerance

20.2 The length tolerance for roof and noncomposite steel floor deck to be lapped is:

□ a. plus / minus 1 inch
□ b. plus / minus 1/2 inch
□ c. plus unlimited / minus 1/2 inch
□ d. no specified tolerance

20.3 The minimum thickness of 18 gauge (0.0474 inch) uncoated steel deck is:

□ a. 0.0474 inch
□ b. 0.045 inch
□ c. 0.0418 inch
□ d. 0.040 inch

20.4 The nominal thickness of 22 gauge uncoated steel deck is:

□ a. 0.0220 inch
□ b. 0.0280 inch
□ c. 0.0295 inch
□ d. 0.0310 inch

20.5 Unless otherwise required on the drawings, steel decks spanning up to and including _____ do not require side lap attachment between supports.

□ a. 3 feet
□ b. 4 feet
□ c. 5 feet
□ d. all span lengths require side lap attachment between supports

20.6 The maximum distance between side lap attachments between supports is:

□ a. 18 inches
□ b. 3 feet
□ c. 4 feet
□ d. 5 feet

20.7 Welding of steel deck systems is done in accordance with:

- □ a. AWS D1.1 - Structural Welding Code - Steel
- □ b. AWS D1.3 - Structural Welding Code - Sheet Steel
- □ c. SDI Manual of Construction with Steel Deck
- □ d. AISC Steel Construction Manual

20.8 The minimum size puddle weld, measured at the exposed surface, for steel deck welds without weld washers is:

- □ a. $^3/_8$ inch
- □ b. $^1/_2$ inch
- □ c. $^5/_8$ inch
- □ d. $^3/_4$ inch

20.9 The maximum <u>average</u> spacing between welds attaching composite steel floor deck to supporting steel is:

- □ a. every rib
- □ b. 12 inches
- □ c. 18 inches
- □ d. 24 inches

20.10 The <u>maximum</u> spacing between welds attaching composite steel floor deck to supporting steel is:

- □ a. every rib
- □ b. 12 inches
- □ c. 18 inches
- □ d. 24 inches

20.11 The maximum <u>average</u> spacing between welds attaching steel roof deck to supporting steel is:

- □ a. every rib
- □ b. 12 inches
- □ c. 18 inches
- □ d. 24 inches

20.12 The edge ribs, also called side laps, of each steel deck panel spanning over 5 feet must be attached to all perimeter supporting steel for:

- □ a. composite floor deck
- □ b. noncomposite floor deck
- □ c. roof deck
- □ d. all of the above

20.13 Weld washers for arc spot welds are required when the deck thickness is less than:

□ a. 23 gauge
□ b. 22 gauge
□ c. 20 gauge
□ d. 16 gauge

20.14 For composite steel floor deck, the minimum distance from top of deck to top of concrete slab is:

□ a. 3/4 inch
□ b. 1 1/2 inches
□ c. 2 inches
□ d. 3 inches

20.15 The minimum size / diameter for screws used for side-lap attachments is:

□ a. 0.18 inch
□ b. #8
□ c. #10
□ d. 1/4 inch

20.16 For noncomposite steel floor deck, the minimum concrete cover above the top of the deck is:

□ a. equal to the height of the deck
□ b. 3/4 inch
□ c. 1 1/2 inches
□ d. 2 inches

20.17 Unless otherwise tested, the minimum thickness of supporting steel for powder-actuated or pneumatically driven fasteners for roof deck and noncomposite floor deck is:

□ a. 1/16 inch
□ b. 1/8 inch
□ c. 3/16 inch
□ d. 1/4 inch

20.18 Edge ribs, the bottom flange of the last rib along the side of a deck panel, for roof deck and noncomposite floor deck, is to be attached to supporting steel:

□ a. at an average spacing of every 12 inches, and a maximum spacing of 18 inches
□ b. when the distance between transverse supports exceeds 5 feet
□ c. at a maximum distance of 3 feet
□ d. need not be attached except at transverse supports

20.19 Deck is to be attached to supporting members, collectors, drag members and perimeter members by:

- □ a. arc spots welds
- □ b. fillet welds
- □ c. mechanical fasteners
- □ d. any of the above

20.20 The minimum length of fillet welds used to attach deck to supporting steel is:

- □ a. $^5/_8$ inch
- □ b. 1 inch
- □ c. $1^1/_2$ inches
- □ d. 2 inches

20.21 For deck that cantilevers beyond a support, the required sidelap attachment is at the end of the deck furthest from the support, and at a maximum spacing between the deck end and the support of:

- □ a. 36 inches
- □ b. 18 inches
- □ c. 12 inches
- □ d. 6 inches

20.22 For deck that will not be directly exposed to a corrosive environment, completed deck weld areas:

- □ a. shall be repaired using a zinc-rich paint
- □ b. shall be repaired by covering an adhesive mastic material
- □ c. shall be repaired using a coating that matches the type used for the deck
- □ d. need no repair

20.23 For deck that will be welded to the supporting steel, the following documents shall be available:

- □ a. WPQRs (Welder Performance Qualification Records) for welding personnel
- □ b. WPSs (Welding Procedure Specifications)
- □ c. PQRs (Procedure Qualification Records) for welds not prequalified
- □ d. all of the above

20.24 For deck that will be mechanically attached to the supporting steel, the following documents shall be available:

- □ a. manufacturer's product data sheets, catalogue data or independent evaluation reports for the fasteners
- □ b. manufacturer's installation instructions
- □ c. either "a" or "b"
- □ d. both "a" and "b"

ANSWER KEY	CHAPTER 20 STEEL FLOOR AND ROOF DECKS

REFERENCES

ANSI/SDI C-2011, Standard for Composite Steel Floor Deck - Slabs, 2011

ANSI/SDI NC-2010, Standard for Non-Composite Steel Floor Deck, 2010

ANSI/SDI RD-2010, Standard for Steel Roof Deck, 2010

ANSI/SDI QA/QC-2011, Standard for Quality Control and Quality Assurance for Installation of Steel Deck, 2011

COSP14, SDI Code of Standard Practice 2014, 2014

		SDI-C-2011	SDI-NC-2010	SDI-RD-2010	SDI QA/QC-2011	COSP14
20.1	b	2.2.B	2.2.B.2	2.2.B		
20.2	c	---	2.2B	2.2B		
20.3	b	2.2.A; Table 2.2.1	2.2.A; Table 2.2.1	2.2.A; Table 2.2.1		C-2.1.2; Table C-2.1
20.4	c	---	---	---		C-2.1.2; Table C-2.1
20.5	c	3.1.C	3.1.E	3.1.D		
20.6	b	3.1.C	3.1.E	3.1.D		
20.7	b	3.2.A	3.2.A	3.2.A		
20.8	c	3.2.C	3.2.C	3.2.C		
20.9	b	3.1.B	---	---		
20.10	c	3.1.B	---	---		
20.11	c	---	---	3.1.C		
20.12	d	3.1.D	3.1.F	3.1.E		
20.13	a	3.2.B	3.2.B	3.2.B		
20.14	c	2.4.B.4.a	---	---		
20.15	c	3.1.6.1	3.1.E.1	3.1.D.1		
20.16	c	---	2.4.B.3.a	---		
20.17	b	---	3.3.C	3.3.C		
20.18	a	---	3.1.D	3.1.C		
20.19	d	3.1.B	3.1.B	3.1.B		
20.20	c	3.2.D.2	3.2.F.2	3.1.F.2		

		SDI-C-2011	SDI-NC-2010	SDI-RD-2010	SDI QA/QC-2011	COSP14
20.21	c	3.1.F.1	3.1.H	3.1.G		
20.22	d					3.6
20.23	d				2.2.E, F & G	
20.24	d				2.2.A	

STUDY GUIDE	CHAPTER 21 WIND AND SEISMIC CONSTRUCTION

OBJECTIVE

To become familiar with the additional fabrication, erection and inspection requirements invoked when the project is located in a designated seismic or high-wind region.

REFERENCES

International Building Code, 2009

Chapter 17 - Structural Tests and Special Inspections
(1702, 1705, 1706, 1707, 1708, 1709, 1710)
Chapter 22 - Steel
(2205)

International Building Code, 2012

Chapter 17 - Structural Tests and Special Inspections
(1704.3, 1704.4, 1704.5, 1705.10, 1705.11, 1705.12)
Chapter 22 - Steel
(2205)

International Building Code, 2015

Chapter 17 - Structural Tests and Special Inspections
(1704.3, 1704.4, 1704.5, 1704.6, 1705.11, 1705.12, 1705.13)
Chapter 22 - Steel
(2205)

AISC 341-10 Seismic Provisions for Steel Buildings, 2010

D1.3. Protected Zones
D2.2. Bolted Joints
Chapter I - Fabrication and Erection
Chapter J - Quality Control and Quality Assurance

AISC 358s2-14 Prequalified Connections for Special and Intermediate Steel Moment Frames for Seismic Applications, 2014

Chapter 3 - Welding Requirements
Chapter 4 - Bolting Requirements

AWS D1.8:2009, Structural Welding Code - Seismic Supplement, 2009

KEY POINTS

International Building Code

- Special Inspections for seismic resistance are required for what conditions in a seismic region?
- What elements must be included in Special Inspections for seismic resistance?
- What must be included in the Contractor's statement of responsibility?
- Special Inspections for wind resistance are required for what conditions in a high-wind region?
- What elements must be included in Special Inspections for wind resistance?
- What is Structural Observation?
- When Structural Observation is required, what is submitted for a building permit?
- Who may perform Structural Observation?
- What reporting requirements apply to Structural Observation?

AISC 341-10 Seismic Provisions for Steel Buildings, 2010

- What bolts must be pretensioned?
- What is the faying surface requirement for bolted joints?
- Who must approve the welding procedures?
- What are the Charpy V-Notch (CVN) requirements for welding filler metals?
- What types of discontinuities must be repaired if made within the protected zone?
- What types of connections and connection materials are prohibited in the protected zone?
- What type of inspection is emphasized for welding?
- What welded joints require nondestructive testing?
- Welds made in which area of a rolled shape require nondestructive testing?

AISC 358s2-14 Prequalified Connections for Special and Intermediate Steel Moment Frames for Seismic Applications, 2014

- What are the special detailing requirements for the use of and removal of steel backing?
- What welds are prohibited at steel backing"
- How may nonfusible backing be used at beam-to-column moment connections?
- What are the requirements for weld tab removal and finish?
- How are the welds for continuity plates to be made?
- Are there special bolting requirements for prequalified moment connections?

AWS D1.8:2009, Structural Welding Code - Seismic Supplement, 2009

- When is supplemental welder qualification testing required?
- What are the CVN requirements for welding filler metals?
- What heat input range may be used when welding?
- What is the maximum wind speed when welding using gas-shielded processes?
- When is intermixed filler metal an issue to be tested?
- What tests are required for the intermixed filler metal condition?
- What are the diffusible hydrogen limits for filer metals?
- What are the storage and exposure requirements for FCAW filler metals?
- What is the maximum interpass temperature permitted?
- Where may tack welds be placed, and in what locations are they prohibited?
- What are the requirements for backing removal and backwelding?
- What are the requirements for weld tab removal and surface finish?
- What are the quality requirements for weld access holes?
- What is the proper sequence for welding the beam bottom flange to the column in a moment connection?
- How are repairs to be made in the protected zone?
- What extra qualification requirements apply to Inspector and NDT technicians?

QUIZ	CHAPTER 21 WIND AND SEISMIC CONSTRUCTION

21.1 When required, Structural Observation:

- □ a. is performed by the Special Inspector
- □ b. is performed by a Registered Design Professional
- □ c. is performed by the Building Official
- □ d. any of the above

21.2 Structural Observation is required for high Seismic Design Categories or high wind speeds when:

- □ a. designated by the Registered Design Professional responsible for the structural design
- □ b. required by the Building Official
- □ c. required for the Occupancy Category
- □ d. any of the above

21.3 The person to perform Structural Observation is employed by:

- □ a. the Owner
- □ b. the Registered Design Professional in Responsible Charge
- □ c. the building department
- □ d. the Contractor

21.4 In high wind applications, what wind-resisting systems or components are required to be addressed in the Statement of Special Inspections?

- □ a. roof cladding and roof framing connections
- □ b. wall connections to roof and floor diaphragms
- □ c. vertical windforce-resisting systems, including attachment to the foundation
- □ d. all of the above

21.5 For seismic applications, Special Inspection of structural steel is required in accordance with:

- □ a. AISC 360
- □ b. AISC 341
- □ c. AWS D1.8
- □ d. all of the above, through reference to AISC 341

21.6 The Contractor's statement of responsibility for main wind- or seismic-force-resisting systems must include:

- □ a. procedures for exercising control within the Contractor's organization
- □ b. acknowledgement of awareness of the special requirements contained in the Statement of Special Inspections
- □ c. identification and qualifications of personnel exercising control of the Contractor's operations
- □ d. all the above

21.7 The Statement of Special Inspections for high seismic applications must identify:

- □ a. additional Special Inspections
- □ b. additional testing to be performed
- □ c. the designated seismic systems and seismic force-resisting systems subjected to additional Special Inspections and tests
- □ d. all of the above

21.8 For seismic work, welding procedures must be approved:

- □ a. by the Inspector
- □ b. by the weld filler metal manufacturer
- □ c. by the Engineer of Record
- □ d. except when "continuous" or "perform" inspection is performed

21.9 All welds used in members and connections in the seismic force-resisting system must be made with filler metals classified to a CVN of:

- □ a. 20 foot-pounds at 0ºF
- □ b. 20 foot-pounds at -20ºF
- □ c. 40 foot-pounds at +70ºF
- □ d. there are no CVN requirements

21.10 Unless in cold environments, which welds in seismic moment frames must be made with filler metals tested to provide a CVN toughness of 40 foot-pounds at +70ºF, in addition to the requirements of the previous question:

- □ a. CJP groove welds
- □ b. Demand Critical welds
- □ c. CJP and PJP groove welds loaded in tension
- □ d. all welds

21.11 High strength bolts used in seismic force-resisting systems must be:

- □ a. snug-tightened
- □ b. pretensioned
- □ c. A490 bolts
- □ d. inspected with a torque wrench

21.12 Except for connections carrying principally direct tension loading, the faying surface used in bolted joints used in seismic force-resisting systems must be:

□ a. Class A
□ b. Class B
□ c. unpainted
□ d. lubricated

21.13 What types of discontinuities, if made in the protected zone of a seismic force-resisting system, must be reported to the Engineer for instructions regarding repair:

□ a. tack welds
□ b. erection aids
□ c. flame cutting
□ d. any of the above

21.14 Unless permitted by qualification test, welded studs are not permitted in the protected zone of a seismic force-resisting system in the following locations:

□ a. beam webs
□ b. beam flanges
□ c. anywhere
□ d. placement of studs is not restricted

21.15 The following items are not permitted in the protected zone of a seismic force-resisting system:

□ a. welded attachments
□ b. bolted attachments
□ c. screwed or shot-in attachments
□ d. all of the above

21.16 Welds made for doubler plates, continuity plates or stiffeners in the k-area of a rolled shape used in a seismic force-resisting system require:

□ a. removal of the weld
□ b. magnetic particle inspection of the weld
□ c. magnetic particle inspection of the web of the rolled shape near the weld
□ d. removal of the attachment

21.17 In a seismic force-resisting system, when a CJP groove weld of ¾-inch throat or greater is made to the side of a heavy column flange $1^1/_2$ inches thick or greater, the following is required:

□ a. ultrasonic testing of the flange prior to welding
□ b. ultrasonic testing of the area behind and near the weld after welding
□ c. magnetic particle testing of the weld
□ d. all of the above

21.18 As a minimum, Quality Assurance Inspectors for welding of seismic force-resisting systems, when working without supervision, are to be qualified:

□ a. as AWS CWIs or SCWIs to AWS QC1
□ b. as WIs or SWIs to AWS B5.1
□ c. as Level II or Level III WIs to CSA W178.2
□ d. any of the above

21.19 In a seismic force-resisting system, mixing which two welding processes in a single joint requires special testing for CVN in the intermixed region:

□ a. SMAW and FCAW-S
□ b. FCAW-S and FCAW-G
□ c. FCAW-S and GMAW
□ d. any of the above

21.20 FCAW, GMAW-C and SAW filler metals used in a seismic force-resisting system must meet what diffusible hydrogen requirement?

□ a. H4
□ b. H8 or lower
□ c. H16 or lower
□ d. not restricted

21.21 When gas-shielded welding processes are used to make welds in a seismic force-resisting system, the wind speed is limited to:

□ a. 1 mile per hour
□ b. 3 miles per hour
□ c. 5 miles per hour
□ d. 10 miles per hour

21.22 Unless otherwise substantiated by testing, the maximum interpass temperature permitted when welding on a seismic force-resisting system is:

□ a. 150ºF
□ b. 350ºF
□ c. 550ºF
□ d. 750ºF

21.23 Supplemental welder qualification testing is required:

□ a. when the weld is Demand Critical
□ b. when the weld joins the bottom beam flange to the column flange
□ c. when the weld must be made by welding through a beam web weld access hole
□ d. only when all of the above are applicable

21.24 Electrode packaging, storage, and exposure control limits are addressed for which welding process that does not have such provisions in AWS D1.1?

- □ a. GMAW
- □ b. FCAW
- □ c. ESW
- □ d. EGW

21.25 Which type of procedure is required to be submitted to the EOR that need not even be available in AISC 360-10?

- □ a. welding procedures
- □ b. bolting procedures
- □ c. cutting procedures
- □ d. erection procedures

21.26 Which connection type is not prequalified in accordance with AISC 358s2-14?

- □ a. WUF-W
- □ b. WUF-B
- □ c. BUEEP
- □ d. KBB

ANSWER KEY	CHAPTER 21 WIND AND SEISMIC CONSTRUCTION

REFERENCES

International Building Code, 2009

International Building Code, 2012

International Building Code, 2015

AISC 341-10 Seismic Provisions for Steel Buildings, 2010

AISC 358s2-14 Prequalified Connections for Special and Intermediate Steel Moment Frames for Seismic Applications, 2014

AWS D1.8:2009 Structural Welding Code - Seismic Supplement, 2009

		IBC, 2009	IBC, 2012	IBC, 2015
21.1	b	1702; 1710.1	202; 1704.5	202, 1706
21.2	d	1710.2; 1710.3	1704.5.1; 1704.5.2	1704.6.1; 1704.6.2
21.3	a	1710.1	1704.5	1706
21.4	c	1705.4.2; 1706.4	1704.3.3; 1705.10.3	1704.3.1; 1704.3.3
21.5	d	1707.2	1705.11	1705.12.1
21.6	b	1709	1704.4	1704.4
21.7	d	1705.2; 1705.3.6	1704.3.1; 1704.3.2	1704.3.1; 1704.3.2

		AISC 341-10	AISC 358s2-14	AWS D1.8:2009
21.8	c	I2.3		
21.9	a	I2.3		6.3.1; Table 6.1
21.10	b	A3.4b; I2.3		6.3.5; Table 6.2
21.11	b	I2.2; D2.2(4)		
21.12	a	I2.2; D2.2(4)		
21.13	d	I2.1 (1)		
21.14	b	I2.1 (2)		
21.15	d	I2.1 (3)		
21.16	c	J6.2a		7.4
21.17	b	J6.2c		7.5
21.18	d	J4, reference to AISC 360-10 N5.2 (a)		7.2.1
21.19	d			6.3.4
21.20	c			6.3.2; Table 6.3
21.21	b			6.2.2.1
21.22	c			6.5.1
21.23	d			5.1.1
21.24	b			6.4
21.25	b	J2.1 (5) See AISC 360-10,N3.2		
21.26	b		2.1; Table 2.1	