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**4.0**

# Building Design & Construction Systems

**2009**

QUESTIONS & ANSWERS John Hardt

ARE  
4.0

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Published by Kaplan AEC Education

30 South Wacker Drive, Suite 2500

Chicago, Illinois 60606-7481

(312) 836-4400

*www.kaplanaecarchitecture.com*

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Printed in the United States of America

08 09 10 10 9 8 7 6 5 4 3 2 1

ISBN-13: 978-1-4277-7031-8

ISBN-10: 1-4277-7031-X

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## ARCHITECTURAL HISTORY

Questions pertaining to the history of architecture appear throughout the ARE. The prominence of historical questions will vary not only by division but also within different versions of the exam for each division. In general, however, history tends to be lightly tested, with approximately three to seven history questions per division, depending upon the total number of questions within the division. One aspect common to all the divisions is that whatever history questions are presented will be related to that division's subject matter. For example, a question regarding Chicago's John Hancock Center and the purpose of its unique exterior cross bracing may appear on the Structural Systems exam.

Though it is difficult to predict how essential your knowledge of architectural history will be to passing any of the multiple-choice divisions, it is recommended that you refer to a primer in this field—such as Kaplan's *Architectural History*—before taking each exam, and that you keep an eye out for topics relevant to the division for which you are studying. It is always better to be overprepared than taken by surprise at the testing center.

simple on-screen icons. The vignettes require candidates to create a graphic solution according to program and code requirements.

Actual appointment times for taking the exam are slightly longer than the actual exam time, allowing candidates to check in and out of the testing center. All ARE candidates are encouraged to review NCARB's *ARE Guidelines* for further detail about the exam format. These guidelines are available via free download at NCARB's Web site ([www.ncarb.org](http://www.ncarb.org)).

### Exam Format

It is important for exam candidates to familiarize themselves not only with exam content, but also with question format. Familiarity with the basic question types found in the ARE will reduce confusion, save time, and help you pass the exam. The ARE contains three basic question types.

The first and most common type is a straightforward multiple-choice question followed by four choices (A, B, C, and D). Candidates are expected to select the correct answer. This type of question is shown in the following example.

Which of the following cities is the capital of the United States?

- A. New York
- B. Washington, DC**
- C. Chicago
- D. Los Angeles

The second type of question is a negatively worded question. In questions such as this, the negative wording is usually highlighted using all caps, as shown below.

Which of the following cities is **NOT** located on the west coast of the United States?

- A. Los Angeles
- B. San Diego
- C. San Francisco
- D. New York**

The third type of question is a combination question. In a combination question, more than one choice may be correct; candidates must select from combinations of potentially correct choices. An example of a combination question is shown on page viii.

## THE EXAM TRANSITION

### ARE 3.1

In November 2005 NCARB released *ARE Guidelines Version 3.1*, which outlines changes to the exam effective February 2006. These guidelines primarily detailed changes for the Site Planning division, combining the site design and site parking vignettes as well as the site zoning and site analysis vignettes. For more details about these changes, please refer to Kaplan's study guides for the graphic divisions.

The guidelines mean less to those preparing for multiple-choice divisions. Noteworthy points are outlined below.

- All division statements and content area descriptions were unchanged for the multiple-choice divisions.
- The number of questions and time limits for all exams were unchanged.
- The list of codes and standards candidates should familiarize themselves with was reduced to those of the International Code Council (ICC), the National Fire Protection Association (NFPA), and the National Research Council of Canada.
- A statics title has been removed from the reference list for General Structures.

### ARE 4.0

In the spring of 2007, NCARB unveiled ARE 4.0, available as of July 2008. According to NCARB, the 4.0 version of the exam will be more subject-oriented than 3.1, and is intended to better assess a candidate's ability to approach projects independently. The format combines the multiple-choice and graphic portions of different divisions, reducing the number of divisions from nine to seven.

The transition will be gradual, with a one-year overlap during which both ARE 3.1 and ARE 4.0 will be administered. Provided you pass at least one ARE 3.1 division prior to May 2008, you can continue to take ARE 3.1 divisions until July 2009.

If you have not passed all ARE 3.1 divisions by June 2009, you will be transitioned to the ARE 4.0 format. You will be given credit for ARE 4.0 divisions according to which 3.1 divisions you have passed. Visit [www.kaplanacarchitecture.com](http://www.kaplanacarchitecture.com) for more details.

In order to avoid being retested on subjects you have already passed, you should develop a strategy for which divisions you take in which order. Here are some key points to keep in mind:

- Building Technology is a key division in the transition; its vignettes will be dispersed across four ARE 4.0 divisions. Be sure to pass Building Technology if you have passed and want credit for any of the following ARE 3.1 divisions: Building Design/Materials & Methods; Construction Documents & Services; General Structures; Lateral Forces; or Mechanical & Electrical Systems.
- Pre-Design and Site Planning content will be shuffled in ARE 4.0: If you pass one, pass the other.
- General Structures, Lateral Forces, and the Structural Layout vignette from Building Technology are being merged into the Structural Systems division. If you pass any of these and want to avoid being retested on material you have already seen, pass all three.

for the GRE or providing tomorrow's doctors the tools they need to pass the MCAT, Kaplan possesses more than 50 years of experience as a global leader in exam prep and educational publishing. It is that experience and history that Kaplan brings to the world of architectural education, pairing unparalleled resources with acknowledged experts in ARE content areas to bring you the very best in licensure study materials.

Only Kaplan AEC offers a complete catalog of individual products and integrated learning systems to help you pass all seven divisions of the ARE. Kaplan's ARE materials include study guides, mock exams, question-and-answer handbooks, video workshops, and flash cards. Products may be purchased individually or in division-specific learning systems to suit your needs. These systems are designed to help you better focus on essential information for each division, provide flexibility in how you study, and save you money.

To order, please visit [www.KaplanAEC.com](http://www.KaplanAEC.com) or call (800) 420-1429.

# SYMBOLS AND ABBREVIATIONS

The following symbols and abbreviations are used in this book and are generally understood in structural design practice.

<b>Symbol or Abbreviation</b>	<b>Meaning</b>
ft. or '	foot
ft <sup>2</sup> or sq. ft.	square foot
ft <sup>3</sup> or cu. ft.	cubic foot
ft.-kip or ft.-k or 'k	foot-kip
ft.-lb. or ft-# or '#	foot-pound
in. or "	inch
in <sup>2</sup> or sq. in.	square inch
in <sup>3</sup> or cu. in.	cubic inch
in.-kip. or in.-k or "k	inch-kip
in.-lb. or in-# or "#	inch-pound
kip or k	kip (1 kip = 1 kilo pound or 1000 pounds)
ksi or k/in <sup>2</sup>	kips per square inch
lb. or #	pound
lb./cu. ft. or #/ft <sup>3</sup> or pcf	pounds per cubic foot
plf or #' or #/ft.	pounds per lineal foot
psf or #/ft <sup>2</sup>	pounds per square foot
psi or #/in <sup>2</sup>	pounds per square inch
Δ (delta)	1. total strain (deformation) 2. thermal expansion or contraction 3. deflection
θ (theta)	a common designation for an angle
π (pi)	the ratio of the circumference of a circle to its diameter, equal to 3.14159
Σ (sigma)	summation of
φ (phi)	strength reduction factor in reinforced concrete design
#	pounds



# QUESTIONS

1. If the roof and ceiling assembly of a structure has a factor of thermal conductance (U-factor) of 0.04, what should be the R-value of the insulation used in this same assembly?

- A. 2.5
- B. 10
- C. 25
- D. 40

2. The ancient Roman structure consisting of a 142-foot-diameter dome resting on a circular masonry wall is the

- A. Parthenon.
- B. Colosseum.
- C. Pont du Gard.
- D. Pantheon.

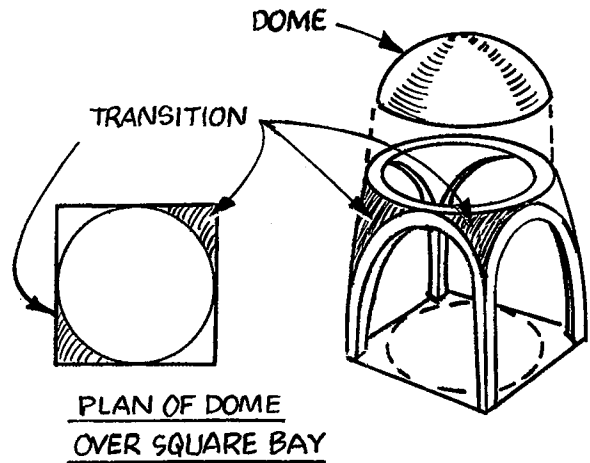
3. Which of the following techniques is most effective in reducing sound transmission through a wall? Check all that apply.

- A. Decrease wall mass
- B. Detach the two faces of the wall from each other
- C. Apply spray-on mineral fiber to both wall faces
- D. Seal or avoid flanking paths

4. Which of the following buildings of the Chicago School is considered to be the first iron-and-steel-framed skyscraper?

- A. Monadnock Building
- B. Carson Pirie Scott Store
- C. Marquette Building
- D. Home Insurance Building

5. In Byzantine architecture, the transition from an upper circular dome to a lower square base was made by four approximately triangular sections, as shown below. What were they called?



- A. Column capitals
- B. Dossierets
- C. Quadripartite vaults
- D. Pendentives

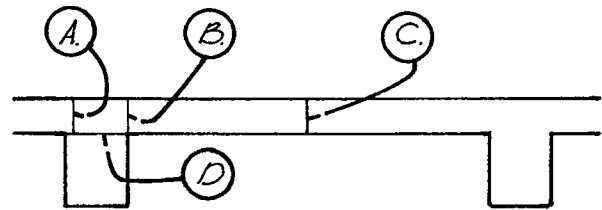
6. In the latter half of the 19th century, buildings with longer spans and greater heights were made possible by the development of steel construction. Which of the following buildings did NOT utilize a metal frame?

- A. Crystal Palace
- B. Home Insurance Co. Building
- C. Reliance Building
- D. Marshall Field Wholesale Store

7. Volatile organic chemicals (VOCs) affect indoor air quality and may originate from which of the following?
- A. Paints and lacquers
  - B. Glues and adhesives
  - C. Building materials and furnishings
  - D. All of the above
8. Which of the following were large iron or steel structures built during the latter half of the 19th century?
- I. Eiffel Tower
  - II. Woolworth Building
  - III. Brooklyn Bridge
  - IV. Crystal Palace
  - V. C.N.I.T. Dome
  - VI. I, II, III, and IV
- A. I, III, and IV
  - B. II, IV, and V
  - C. I, III, and V
9. Life-cycle costing is an economic evaluation of architectural elements that includes which of the following factors?
- I. First cost
  - II. Maintenance costs
  - III. Repair costs
  - IV. Replacement cost
- A. I
  - B. II, III, and IV
  - C. II and IV
  - D. All of the above
10. An interior partition is constructed of metal studs 16 inches on center with one layer of  $\frac{5}{8}$ -inch Type "X" gypsum wallboard on each side. What is the fire-resistive rating of the partition?
- A. None
  - B. One hour
  - C. Two hours
  - D. Three hours
11. Asbestos is a mineral fiber that has been used commonly in a variety of building construction materials. Although it has been out of widespread use for many years, in older buildings asbestos can still be found in which materials?
- I. Pipe and furnace insulation
  - II. Shingles
  - III. Floor tiles
  - IV. Insulation
- A. I and II
  - B. II and III
  - C. I, III, and IV
  - D. All of the above

12. A one-hour fire-resistive rating for a drywall wood stud interior partition may be achieved as follows: 2-inch  $\times$  4-inch wood studs at 16-inch on center are covered with  $\frac{5}{8}$ -inch fire-rated gypsum wallboard, and the joints are taped and sealed. If one wished to increase the fire rating using the same construction, one would likely specify that
- the studs would be placed 8 inches on center.
  - the same  $\frac{5}{8}$ -inch fire-rated gypsum wallboard be applied over a base layer of  $\frac{3}{4}$ -inch plywood.
  - three layers of  $\frac{3}{4}$ -inch gypsum wallboard be applied on both sides.
  - two layers on  $\frac{5}{8}$ -inch fire-rated gypsum wallboard be applied to both sides.
13. A wall that is classified by the building code as nonbearing is a(n)
- interior wall.
  - wall that has no separate footing.
  - wall that is less than 50 percent solid.
  - wall that supports only its own weight.
14. Select the correct statement about the construction of semicircular masonry arches.
- Centering is not usually necessary.
  - Centering is usually necessary until placing of the keystone.
  - The arches are almost always parabolic in shape.
  - The maximum arch span is about 60 feet.
15. Applying a mortar coat to control leakage in masonry walls is called \_\_\_\_\_.

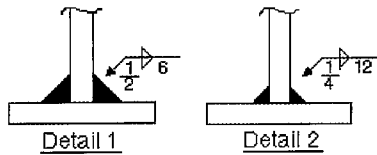
16. You are designing a building in a city with a moderate climate and you have specified grade MW brick for the exterior walls. The contractor proposes to substitute grade SW. What should be your response?
- Accept the substitution
  - Reject the substitution
  - Accept the substitution, provided masonry prism tests indicate that the bricks have adequate strength
  - Allow the SW grade bricks to be used for interior walls only
17. A section through a reinforced concrete slab and beam floor system is shown. Which of the locations shown is best for a construction joint?



18. Select the correct statement, concerning masonry joints, from among those that follow.
- The best type of joint to resist water penetration is either a weather-struck joint or a trowel-struck joint.
  - The best type of joint to use on a masonry wall that is to receive a plastered finish is a flush joint.
  - The type of joint that can be easily formed with a trowel is a v-shaped joint.
  - The types of joints used on interior masonry walls are essentially the same as those used on walls exposed to the weather.

19. Brick used in areas of heavy rain, snow, or continual freezing should conform to which of the following grades?
- A. SW
  - B. MW
  - C. NW
  - D. FBX
20. In which of the following brick bonding patterns are the wythes tied together with headers?
- I. Flemish bond
  - II. English bond
  - III. Running bond
  - IV. Common bond
- A. I, II, and III
  - B. II, III, and IV
  - C. III only
  - D. I, II, and IV
21. Which of the following historic structures contains a dome built without any temporary centering?
- A. The Pantheon
  - B. Hagia Sophia
  - C. Santa Maria del Fiore in Florence
  - D. The Parthenon
22. An architect might specify light gauge punched steel studs in place of conventional wood studs in those cases where
- A. there is low relative humidity and sudden climactic changes.
  - B. a degree of fire resistance is required that is unobtainable with wood.
  - C. the situation calls for unusual speed of erection.
  - D. cost is a determining factor.
23. Which of the following statements concerning galvanizing is INCORRECT?
- A. Galvanizing involves applying a protective coating of zinc to iron or steel.
  - B. Galvanizing and sherardizing treatments are essentially the same.
  - C. The corrosion protection achieved is proportional to the thickness of the coating.
  - D. The most common galvanized materials used in construction are iron sheet and strip.
24. Exposed aluminum sections tend to
- A. rust.
  - B. corrode.
  - C. oxidize.
  - D. remain bright indefinitely.
25. In the selection of an exposed flashing material, several metals have specific properties that make their use advantageous in certain situations. In this regard, select the CORRECT statements. Choose all that apply.
- A. Copper has a tendency to tarnish when exposed to weather.
  - B. Galvanized steel is immune to rust and corrosion.
  - C. Soldering aluminum is difficult and should be avoided.
  - D. Stainless steel requires no additional protective coating.
  - E. Copper and stainless steel expand and contract at about the same rate.

26. The two fillet welds shown below have the same strength. The total amount of weld metal in Detail 1 is



- A. the same as that in Detail 2.  
 B. double that in Detail 2.  
 C. half of that in Detail 2.  
 D. four times that in Detail 2.
27. What is the most common type of structural weld?
- A. Full penetration weld  
 B. Plug weld  
 C. Fillet weld  
 D. Groove weld
28. How does a light-gauge steel member differ from a conventional structural steel member?
- I. The light-gauge member is usually cold-formed.  
 II. The light-gauge member cannot be welded.  
 III. The light-gauge member is formed from a single piece of material and is therefore uniform in cross section.
- A. I and II  
 B. II and III  
 C. I and III  
 D. I, II, and III
29. Which of the qualities listed below are among the unique properties that make weathering steel a desirable exterior material?
- I. It does not rust.  
 II. It requires no protective coating.  
 III. It is virtually maintenance free.  
 IV. It ultimately weathers to a deep brownish-red finish that resists corrosion.  
 V. It provides an excellent base for exterior finishes.
- A. I, II, and III  
 B. II, III, and IV  
 C. III, IV, and V  
 D. I, II, and IV
30. The process that employs an electric current and an electrolytic solution to deposit a metallic coating on steel is called \_\_\_\_\_.
31. Steel floor decking is widely used because of its great strength, light weight, and speed of construction. Which of the following statements concerning steel decking is true?
- A. Because of the smooth finish of steel decking, composite action of the decking and the concrete floor slab is not permitted.  
 B. The most typical method of attaching steel decking to the supporting framework is welding.  
 C. When a concrete floor fill is placed over steel decking, no additional fireproofing of the steel decking or frame is required.  
 D. Steel decking is often used for electrical raceways, because it provides easy access from below.

32. Select the correct statement from those that follow.
- A. Steel nails can be used to fasten stainless steel without any concern about galvanic action.
  - B. Conduits and pipes of aluminum are often used in reinforced concrete construction, because the concrete forms an effective barrier preventing galvanic action between aluminum and steel.
  - C. All ferrous metals contain some silicon, and small variations in silicon content have an important influence on their properties.
  - D. Steel can be formed by a variety of methods, but not extruded.
33. The cost of connections in structural steel construction is
- I. a significant factor in the selection of structural steel systems.
  - II. always less for bolted connections than for welded connections.
  - III. usually less for shop connections than for field connections.
- A. I and III
  - B. I, II, and III
  - C. I only
  - D. III only
34. Select the correct statement about the fire-retardant treatment of wood.
- A. It decreases the rate of flame spread.
  - B. It is used for light construction only.
  - C. It generally consists of a coating of protective material over the wood surface.
  - D. The chemicals used are the same as those for decay protection.
35. Which of the following statements about glued laminated timber is correct?
- A. Laminated members are manufactured from the longest pieces of lumber commonly available.
  - B. Laminations may vary in thickness, but in no case are they less than 1-½ inches thick.
  - C. Solid laminated timbers, in straight lengths, can readily span 60 feet or more.
  - D. The finest appearance grade of glued laminated members is “architectural grade.”
36. There are a number of common protective treatments that may be applied to timber, such as those that protect against fire and harmful insects. The one disadvantage they all share is that they
- A. reduce the strength of timber.
  - B. increase the construction cost.
  - C. create greater difficulties in handling.
  - D. are unable to hold a finish.
37. Select the CORRECT statements regarding glued laminated (glulam) beams. Check all that apply.
- A. Cambered members are stronger than straight members of the same size.
  - B. Deep members have a lower allowable unit stress than shallow members.
  - C. When the depth of a beam exceeds its breadth, the allowable unit stress in bending may have to be reduced.
  - D. Allowable design stresses increase proportionately with appearance grades.

38. In conventional wood framed structures, the purpose of a purlin is to
- A. provide continuous support over openings cut in a wall surface.
  - B. produce a positive connection between two opposite sloping rafters in the same plane.
  - C. form the angle of a hip roof and support the jack rafter ends.
  - D. support the roof rafters and, consequently, a portion of the roof load.

39. The standard unit of measure for lumber is the board foot, which is defined as
- A. the volume of lumber in a 12-inch by 12-inch by 12-inch timber.
  - B. one-twelfth of a cubic foot of lumber.
  - C. a nominal one-inch thick board that is 12-inches wide.
  - D. the weight of a 1-inch by 12-inch board that is 12-inches long.

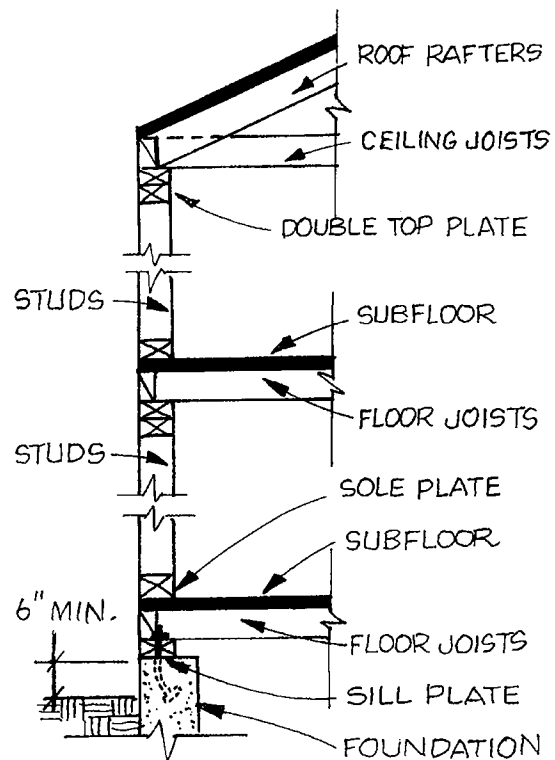
40. The shrinkage of wood as it loses moisture must be considered in the design and detailing of wood members. In this regard, which of the following statements is correct?
- A. A wood stud shrinks most in its length.
  - B. A log shrinks most radially.
  - C. A joist shrinks most in its depth.
  - D. A solid wood girder six inches wide shrinks less than a girder built up of three two-inch-wide members.

41. The principal factor that determines concrete strength is the
- A. quality of aggregates used.
  - B. water-cement ratio.
  - C. type of admixtures used.
  - D. type of portland cement used.

42. Which of the following is the usual order for removal of concrete forms, from first removal to last removal?

- I. Slab bottom forms
  - II. Beam bottom forms
  - III. Beam side forms
- A. I, II, III
  - B. I, III, II
  - C. III, I, II
  - D. II, III, I

43. The section shown illustrates what type of framing?



- A. Heavy timber construction
- B. Mortise-and-tenon framing
- C. Balloon framing
- D. Platform framing

