PRACTICE EXAM 4: STRUCTURAL STEEL IRONWORKER SIMULATION (100 QUESTIONS)

This practice exam contains 100 questions covering all domains of the NCCER Industrial Ironworker assessment (IRON30_03). Select the single best answer for each question. A minimum score of 75 percent (75 correct) is required to pass. A basic non-printing calculator is permitted. Allow no more than 2 hours to simulate test conditions.

1. A rotation-resistant wire rope is specified for a crane application where the load would otherwise spin. What characteristic of rotation-resistant rope prevents load spin compared to a standard 6×19 rope?

A. Rotation-resistant rope uses galvanized wires that grip the sheave more firmly, preventing the load from rotating under friction

B. Rotation-resistant rope has an opposite-lay outer strand layer that produces opposing torque, causing the rope's torsional forces to cancel and preventing the load from rotating

C. Rotation-resistant rope is larger in diameter than standard rope of the same load rating, so its greater mass resists rotational force

D. Rotation-resistant rope is fabricated with fiber-core strands that absorb torsional energy before it can reach the hook and load

2. A four-leg wire rope bridle sling is used to lift a structural assembly from four pick points. When calculating the load per sling leg, which condition governs the rated capacity check?

A. The total load is divided equally by four, and the capacity of the lightest-rated leg determines whether the assembly can be lifted

B. The total load is divided equally by four and multiplied by the sling angle factor; all four legs must individually meet this requirement

C. Only the two diagonally opposite legs are checked, because an asymmetric load will place all weight on two legs

D. The rated capacity is checked against the total load, because the master link at the top of the bridle carries the full weight regardless of the number of legs

3. Which of the following conditions on a wire rope requires immediate removal from service according to ASME B30.9, regardless of any other inspection findings?

A. Evidence of any kink — a permanent distortion caused by a loop being pulled tight — even if the rope otherwise appears undamaged

B. Surface oxidation (reddish-brown discoloration) visible on the outermost wires of any strand

C. A single broken wire at a point more than one lay length from the nearest previous broken wire

D. Loss of visible lubricant on the outer wires over more than half the rope's length

4. A choker hitch has a rated capacity of 75 percent of the wire rope sling's vertical hitch rating. If a sling's vertical rated capacity is 12,000 pounds, what is the maximum load for this sling in a choker hitch configuration?

A. 6,000 lb

B. 8,400 lb

C. 9,000 lb

D. 12,000 lb

5. A screw-pin shackle and a bolt-type (safety) shackle are both rated for the same working load. In which application should the bolt-type shackle be used instead of the screw-pin shackle?

A. In permanent or long-term rigging applications where the shackle pin could work loose from repeated loading cycles or load rotation

B. In light-duty rigging where the load will never exceed 50 percent of the shackle's rated working load limit

C. In applications where the shackle will be proof-tested at 200 percent of its rated capacity before each use

D. In overhead rigging only when the load hangs directly below the shackle without any horizontal force component

6. The fleet angle of a wire rope running from a drum to the first sheave affects rope wear. What is the maximum recommended fleet angle for wire rope running on a smooth drum?

A. One degree maximum to prevent any lateral wear on the rope as it wraps

B. Two degrees maximum for smooth drums and three-and-a-half degrees for grooved drums, per industry practice

C. Five degrees for all drum types because modern rope constructions are rated for this maximum angle

D. Fleet angle does not affect rope wear — only load and sheave diameter determine wire rope life

7. A block-and-tackle arrangement has 3 parts of line supporting the lower (moving) block. A load of 7,500 pounds must be raised. Ignoring friction, what is the line pull required?

A. 1,500 lb

B. 1,875 lb

C. 2,250 lb

D. 2,500 lb

8. Synthetic round slings (web-wound-core slings) use a color-coding system to identify their rated capacity. What color identifies a synthetic round sling with a vertical rated capacity of 13,200 pounds (6 ton)?

A. Green — for 2,100 lb (1 ton) vertical rated capacity

B. Red — for 5,300 lb (2.5 ton) vertical rated capacity

C. Blue — for 13,200 lb (6 ton) vertical rated capacity

D. Orange — for 42,000 lb (19 ton) vertical rated capacity

9. Before a crane pick, the rigger must determine the load's center of gravity (CG). If the CG is not centered between the pick points, what will happen when the load is lifted?

A. The load will rise evenly because the crane hook always centers itself over the geometric center of the sling assembly

B. The load will tilt so that the heavier side is lower, and the angle of tilt will depend on how far the CG is offset from the center of the pick points

C. The load will spin to align the CG below the hook, which is acceptable as long as tag lines are used

D. The crane will detect the off-center CG through its load-moment indicator and automatically reposition the hook before the pick

10. For a 6×19 classification wire rope in a running-line application, what is the ASME B30.9 criterion for removal from service based on broken wires in one lay length?

A. 3 broken wires in one lay length

B. 6 broken wires in one lay length

C. 12 broken wires in one lay length — for wire rope with 6×19 classification

D. Any single broken wire in the rope, regardless of location

11. An eyebolt is rated for 2,000 pounds when loaded vertically (in-line with the eyebolt's shank axis). The same eyebolt is loaded at a 45-degree angle from vertical. What happens to the safe load capacity?

A. Capacity increases because angular loading distributes the force over a larger contact area in the tapped hole

B. Capacity remains the same because the eyebolt is designed for the full rated load in any direction within its plane

C. Capacity decreases by exactly 50 percent, to 1,000 pounds, for any angular loading between 0 and 90 degrees

D. Capacity is significantly reduced — standard carbon-steel eyebolts must be derated for angular loading per manufacturer's tables, and a 45-degree angle may reduce capacity to 30 percent or less of the vertical rating

12. The minimum included angle between the legs of a choker hitch — the angle formed at the choke point as the sling wraps around the load — affects the sling's capacity. What is the minimum recommended included angle at the choke?

A. 120 degrees minimum included angle at the choke — tighter angles impose excessive stress on the sling eye and body at the choke point

B. 90 degrees minimum included angle at the choke — angles below this reduce capacity to below the 75 percent choker rating

C. 60 degrees minimum included angle, which is acceptable for synthetic slings but prohibited for wire rope slings

D. There is no minimum angle requirement for choker hitches — the 75 percent reduction factor already accounts for all possible choke configurations

13. A two-leg wire rope bridle sling has legs forming a 60-degree angle from vertical (measured from the load's vertical axis). The sling angle factor for this configuration is 1.155. If the total load is 20,000 pounds, what is the tension in each sling leg?

A. 10,000 lb — each leg carries half the load because the angle factor is applied to the total, not per leg

B. 11,550 lb — each leg bears the half-load multiplied by the sling angle factor of 1.155

C. 17,320 lb — the sling angle factor of 1.155 is multiplied by the full load because both legs share the angle

D. 23,100 lb — the total load multiplied by 1.155 gives the combined sling assembly tension to be shared by the two legs

14. When selecting a shackle for a rigging application, the bow (body) of the shackle must be sized so that the sling eye seats properly. What is the consequence of using a shackle with a bow that is too narrow for the sling eye?

A. The sling eye will contact the shackle pin rather than the bow, concentrating the load on the pin in a configuration it is not rated for and reducing the connection's capacity

B. The sling eye will work loose during the lift because the narrow bow cannot grip the eye adequately

C. The shackle's working load limit doubles because the narrow bow provides a mechanical grip that reinforces the pin

D. There is no consequence — shackle bow dimensions are nominal, and any eye that fits over the pin is acceptable

15. A two-leg wire rope bridle sling supports a 6,000-pound load. Each sling leg forms a 30-degree angle from horizontal. What is the tension in each sling leg?

A. 3,000 lb

B. 5,196 lb

C. 6,000 lb

D. 8,485 lb

16. When hoisting a long, slender load such as a structural column using a two-leg sling, what rigging aid is sometimes used to prevent the sling legs from sliding toward the center of the load?

A. A spreader bar or lifting beam, which holds the sling legs apart at a fixed distance and prevents them from converging toward the midpoint of the load

B. Safety wire laced through the sling eyes and around the load, to physically pin the sling legs at the desired spacing

C. A tagline tied at each end of the load and held by two workers who pull outward to keep the sling legs spread

D. An outrigger beam bolted to the top of the load at each pick point, creating an elevated attachment point that geometrically prevents leg convergence

17. In an asymmetric lift, where the load's center of gravity is not at the geometric center of the pick points, two sling legs of different lengths are used to equalize the lift angle. Which leg is longer?

A. The leg on the lighter (higher) side of the load is longer, so that its lower attachment point raises the lighter end to level the load

B. The leg on the heavier (lower) side of the load is longer, so that the heavier side is raised proportionally more than the lighter side

C. Both legs are always the same length in an asymmetric lift — load equalization is achieved by repositioning the hook laterally instead

D. The longer leg is selected randomly and the leveling is adjusted by changing the hook block position after the load leaves the ground

18. A wire rope has developed a kink — a tight loop that was pulled down, permanently distorting the rope's cross-section. What is the correct action?

A. Secure both ends and apply a controlled straightening tension to re-align the strands before returning to service

B. Heat the kinked section with a torch to anneal the steel, then straighten it while hot and allow it to cool slowly

C. Remove the kinked section by cutting it out, and re-terminate the rope if sufficient length remains

D. Remove the rope from service entirely — kinked wire rope has permanently distorted wire and strand geometry and cannot be safely used or repaired

19. Before making any crane pick, OSHA 1926.1412 requires that the weight of the load be determined. Which of the following methods is acceptable for establishing the load weight prior to the lift?

A. Use the engineer's stamped lift plan, which includes calculated load weights from structural drawings and material specifications — confirmed weight from engineering documentation is an acceptable method

B. Ask the delivery driver for the truck weight and subtract the truck's unladen curb weight

C. Estimate the load weight based on visual comparison to similar loads that have been weighed on the same project

D. Use the load indicator on the crane hook as the primary weight measurement before the load is verified by another method

20. OSHA 1926.1427 requires crane operators to be qualified or certified. What is the primary pathway for crane operator certification in the United States?

A. Passing a written safety examination administered by the crane's manufacturer at the time of purchase or lease

B. Completing 2,000 hours of documented crane operation under the supervision of a journeyman operator

C. Obtaining a state commercial driver's license with a crane endorsement from the state's department of motor vehicles

D. Passing a written and practical examination administered by an accredited crane operator testing organization such as NCCCO, demonstrating knowledge and skill specific to the crane type

21. Personnel hoisting using a crane-supported work platform (man basket or personnel platform) is permitted only as a last resort under OSHA 1926.1431. Before a personnel hoist can proceed, what trial lift must be performed?

A. A 50 percent overload trial lift held for 5 minutes to verify the crane and rigging can support the platform and maximum intended load

B. A single-personnel lift to a height of 10 feet to check the platform for stability before loading it with the full work crew

C. A test lift of the unloaded platform to the maximum working height, followed by a proof-load trial at 125 percent of maximum intended load

D. A trial lift in which the loaded platform is raised 2 to 3 feet, held for 5 minutes, swung through the full working arc, and inspected before personnel enter at elevation

22. OSHA 1926.1404 requires crane assembly and disassembly to be directed by a competent person. What additional qualification is required when the assembly procedure involves technical procedures specified by the crane manufacturer?

A. A competent person who also holds a current crane operator certification from an ANSI-accredited testing organization

B. An OSHA 500 Train-the-Trainer certificate, which qualifies the person to direct rigging and assembly operations

C. A qualified person who has completed the specific technical training required for the crane make and model, in addition to the competent person overseeing the assembly

D. No additional qualification beyond competent person is required; a competent person is by definition qualified for all assembly procedures under OSHA Subpart CC

23. When reading a crane load chart, the 'working radius' is the key input that determines rated capacity. How is working radius measured?

A. From the center of the crane's main hoist drum to the hook block at the bottom of the hook travel

B. From the outermost edge of the crane's counterweight to the center of the load being lifted

C. Horizontally from the crane's axis of rotation (center pin) to the center of the vertical hoist line with the load applied and the hook block directly below the boom tip

D. From the boom foot pin to the hook block, measured along the boom centerline as the boom length

24. A lattice-boom crane is equipped with a fixed jib attached to the tip of the main boom. The effect of adding a jib is primarily to do which of the following?

A. Increase the crane's rated capacity at normal boom angles because the jib adds a secondary structural load path through the mast

B. Extend the crane's horizontal reach and increase hook height beyond what the main boom alone can achieve, but rated capacity at the tip of the jib is lower than main-boom capacity at the same radius

C. Replace the main boom entirely for all lifting operations; main boom and jib cannot be rigged simultaneously

D. Add a second independent hoist line that can be used in tandem with the main hoist for improved load control

25. A lattice-boom crane hoist has a load block that uses 5 parts of line. The load to be lifted weighs 15,000 pounds. Ignoring friction, what is the required line pull on the running rope?

A. 2,500 lb

B. 3,000 lb

C. 3,500 lb

D. 4,000 lb

26. An all-terrain crane can travel on public roads at highway speed under its own power. How does this differ from a rough-terrain crane in terms of road travel?

A. All-terrain cranes use pneumatic tires on all axles, while rough-terrain cranes use solid rubber tires that limit road travel to crawl speed

B. All-terrain cranes require a crane operator to drive from the crane cab, while rough-terrain cranes must be driven from a separate truck cab

C. Both crane types can travel at highway speed; the only difference is that all-terrain cranes have a higher top speed on paved surfaces

D. All-terrain cranes are designed for highway travel at rated speeds, while rough-terrain cranes have low-speed single-engine powertrains intended for off-road movement and are not designed for highway travel

27. When a crane lifts a load and accelerates it upward, an additional force is imposed on the crane's structure beyond the static load weight. What is this additional force called, and how does it affect the crane's operating margin?

A. Dynamic loading — the inertial resistance of the load to acceleration adds to the hook load during hoisting, reducing the operating margin below what the static load alone would indicate

B. Resonance loading — the natural frequency of the boom amplifies the hook load when the hoist speed matches the boom's natural frequency

C. Geometric amplification — as the load rises, the effective working radius decreases and the crane's rated capacity increases to compensate for the higher speed

D. Friction loading — the hoist rope's friction in the sheaves increases the effective hook load during vertical travel but decreases it during lowering

28. A tower crane's mast foundation is typically required to transfer which types of forces into the structure below it?

A. Vertical compression from the crane's dead load and hook load only; tower cranes are self-stabilizing and impose no horizontal or overturning forces

B. Only the overturning moment from the loaded jib; the mast weight is carried by the jib counterweight system

C. Vertical loads (compression and tension from hook load and counterweight), horizontal shear from wind and dynamic forces, and overturning moments from the crane's load-moment combination

D. Only the lateral wind load on the mast; all vertical loads from the hook and counterweight are carried by the crane's slewing ring

29. What is the primary stability advantage of a crawler crane compared to a rubber-tired mobile crane of similar capacity?

A. A crawler crane's tracks are always in contact with the ground along their full length, providing a wider effective base and greater resistance to tipping than a wheel-mounted crane on outriggers

B. A crawler crane can travel with a suspended load without any stability reduction, unlike a rubber-tired crane, which requires outriggers to be fully deployed even for travel

C. A crawler crane's counterweight automatically adjusts its position during picks, while a rubber-tired crane's counterweight is fixed

D. Crawler cranes have lower ground bearing pressure than rubber-tired cranes of the same capacity because the track pads spread the load more effectively than outrigger pads

30. OSHA 1926.1415 requires a crane to be shut down and secured when wind speeds or lightning pose a hazard. Crane manufacturers typically specify a maximum wind speed for operation. What immediate action must the operator take when a thunderstorm is approaching?

A. Continue operating until lightning is visible within 1 mile, then lower the hook block to ground level and lock the controls

B. Slow down hoisting operations and use extra tag lines during thunderstorm conditions to maintain load control

C. Lower the load to the ground, lower the boom to its travel position if feasible, and secure the crane per the manufacturer's procedures before evacuating to shelter

D. Contact the general contractor's office and await authorization before shutting down, because production decisions require management approval

31. On a lattice-boom crane, the boom hoist (topping lift) is used to raise and lower the boom angle, while the main hoist is used to raise and lower the hook and load. If the boom hoist rope is found to be undersized compared to the main hoist rope, what hazard results?

A. No hazard — boom hoist loads are always lower than hook loads because the boom angle changes slowly and the rope is not loaded during picks

B. The undersized boom hoist rope may fail during boom lowering, causing the boom to drop suddenly and potentially overturning the crane or striking workers below

C. An undersized boom hoist rope causes the boom to drift upward uncontrollably when the load is applied, reducing the effective working radius

D. The undersized rope causes excessive friction in the boom hoist sheaves, reducing the accuracy of the load chart's boom angle readings

32. An anti-two-block (ATB) device is required on cranes used in construction. What does the ATB device protect against?

A. It prevents the crane from two-blocking — the condition where the load block contacts the boom tip, placing the hoist rope in a direct pull that bypasses the sheaves and can cause the rope or boom tip to fail

B. It prevents two separate cranes from operating within each other's swing radius, ensuring that simultaneous operations cannot overlap

C. It detects when two sling legs on a multi-leg bridle are both loaded beyond 50 percent of capacity, indicating an off-center CG

D. It monitors the load on both the boom hoist and main hoist simultaneously and locks out one if the combined load exceeds the crane's rated capacity

33. A forklift's rated capacity is shown on the nameplate as 5,000 lb at a 24-inch load center at maximum lift height. The actual load to be picked has its center of gravity at 36 inches from the forks' face. How does this affect the permissible load?

A. The permissible load is reduced because the actual 36-inch load center exceeds the nameplate's 24-inch rated center; the capacity at 36-inch center must be found on the load center capacity chart

B. The permissible load is unchanged — the 24-inch load center applies to the forks' geometric center, and a 36-inch load center is within the forks' 48-inch length

C. The permissible load increases by 50 percent because the longer moment arm creates mechanical advantage for the forklift's tipping mechanism

D. The rated capacity applies at all load center distances as long as the load is within the fork length; the 24-inch load center is a reference point, not a limit

34. During column plumbing, the ironworker discovers the column is plumb in both planes but is rotated (twisted) about its vertical axis so the flanges are not aligned with the building grid. Which adjustment corrects this condition?

A. Tighten the north and south guy wires simultaneously while releasing the east and west guys to rotate the column back to grid

B. Push the column top laterally in the direction of the web to impart the corrective rotation without affecting plumb

C. Loosen the column's baseplate anchor bolts, rotate the column, and re-tighten the anchor bolts before rechecking plumb

D. Apply a rotational force at a lever arm on the column web using an ironworker's bar while anchor bolts hold the base, checking rotation with a magnetic angle gauge

35. Temporary bracing on a structural steel frame must not be removed until which condition is met?

A. The crane operator has confirmed that the crane is no longer needed on the project and will not be used to apply lateral loads to the frame

B. The general contractor's superintendent issues a written release authorizing bracing removal for each floor level

C. The frame has been made self-supporting through the installation and completion of the permanent lateral load-resisting system at that level, as confirmed by the engineer of record

D. All structural steel bolts in the entire building have been fully tensioned and inspected by a Special Inspector

36. Headed shear studs for composite floor construction are welded to the top flange of structural steel beams. What is the correct sequence for stud installation relative to the deck placement?

A. All studs are welded before deck placement so that the stud welder has unobstructed access to the beam flange from above

B. Studs may be welded either before or after deck placement; when welded through deck, the welder burns through the deck material and fuses the stud to the beam flange in a single arc cycle

C. Studs are always welded after deck placement and removal; the deck is a temporary form that is stripped before final stud installation

D. Studs are installed in the fabrication shop before the beam is delivered to the site, eliminating field welding entirely

37. A structural connection detail shows a 4-row bolt pattern with 3 bolts per row. How many bolts are required to complete this connection?

A. 9 bolts

B. 12 bolts

C. 15 bolts

D. 18 bolts

38. When metal floor deck is attached to a secondary beam that frames into a primary girder, which structural purpose does the deck-to-beam attachment serve beyond supporting the concrete load?

A. The deck attachment prevents the secondary beam from deflecting vertically during concrete placement by acting as a continuous vertical support

B. The deck attachment holds the secondary beam from lateral movement during concrete placement but has no structural function in the finished building

C. The deck attachment transfers in-plane (diaphragm) forces from the deck to the beam, allowing the floor system to act as a horizontal diaphragm that transfers lateral loads to the building's vertical lateral force-resisting system

D. The deck attachment is only required during construction to prevent wind from lifting the deck sheets; it has no structural function once the concrete has cured

39. OSHA Subpart R requires that column splices in multi-story construction be located at a minimum height above the floor below. What is this minimum height?

A. 3 feet above the finished floor level to allow connector access to the floor level splice bolts from below

B. 4 feet above the finished floor level to provide a working height for the connecting ironworkers

C. 6 feet above the top of the highest structural member or floor at the level below the splice

D. 4 feet above the floor, and not less than 12 inches above the highest decked level at that tier — per OSHA 1926.756(c)

40. Under OSHA Subpart R, what minimum number of ironworkers must be present at any structural steel erection operation?

A. A minimum of two ironworkers must be present at all times during structural steel erection — working alone is prohibited because a solo worker cannot be assisted if injured or if a load becomes uncontrolled

B. No minimum number is specified by OSHA — crew size is determined by the erection contractor based on efficiency and schedule

C. A minimum of four ironworkers, because OSHA requires two connectors and one signal person in addition to the crane operator for all erection operations

D. Three ironworkers minimum: one connector, one bolt-up worker, and one designated safety monitor for fall protection

41. A composite beam is designed for 50 percent composite action. The full-composite stud requirement is 32 studs. How many studs must actually be installed to achieve 50 percent composite action?

A. 16 studs — 50 percent composite requires exactly half the full-composite stud count

B. 20 studs — a minimum of 25 percent additional studs are added above the theoretical minimum for construction safety

C. 24 studs — AISC requires a minimum of 75 percent composite for any beam designated as composite

D. 32 studs — partial composite beams must still install the full stud count, with the composite ratio adjusted through the concrete mix

42. A pre-engineered metal building (PEMB) uses tapered I-section rafters and columns that differ structurally from conventional wide-flange sections. Which ironworking consideration is unique to PEMB erection?

A. PEMB columns cannot be plumbed with conventional guy wire systems because the tapered webs deflect laterally under lateral guy force

B. PEMB members have thinner webs and flanges than conventional steel, making them more susceptible to bending and distortion during handling; rigging must avoid concentrated point loads on the thin web

C. PEMB sections are galvanized and cannot be welded in the field; all field connections must be bolted using the manufacturer's proprietary fasteners

D. PEMB erection does not require an ironworking crew — the manufacturer sends trained installation technicians who handle all erection activities

43. Beam elevation tolerances in structural steel erection are governed by AISC Code of Standard Practice Table 7.13. What is the permitted elevation variation at the top of a steel beam at a column?

A. +0 / −1/4 inch from the theoretical elevation shown on the structural drawings

B. +/− 1/8 inch from the theoretical elevation — the tightest tolerance to protect composite deck elevations

C. +/− 3/8 inch from the theoretical elevation at columns and +/− 1/2 inch at midspan

D. +/− 1/4 inch from the theoretical elevation shown on the structural drawings, at the beam's top flange at the column face

44. A tack weld is sometimes used in structural steel erection to temporarily hold members in position before final bolting or welding is completed. What governs the size and quality of tack welds in structural connections?

A. Tack welds are temporary and exempt from all structural welding code requirements; any weld that holds the member in position is acceptable

B. Tack welds may be as small as 3/16 inch regardless of the base metal thickness, because they carry no structural load

C. Tack welds that will be incorporated into final welds must meet the same quality standards as the final weld, including minimum size per base metal thickness, and must be made by qualified welders using approved procedures

D. Tack welds are prohibited in structural connections by AWS D1.1 and must be replaced with mechanical fasteners before the final weld is deposited

45. OSHA 1926.756(a) requires that a minimum number of bolts be installed in each structural connection before any additional loading is applied or before the connector moves to the next connection. What is this minimum?

A. One bolt per connection — one bolt is the minimum to transfer shear until the connection crew can follow up

B. The number of bolts specified in the erection drawings for that connection, but not fewer than two bolts per connection at opposing ends

C. All bolts in the connection must be installed before the connector can move on

D. One-third of the connection's bolt count, rounded up, to distribute load before full bolt installation

46. A W16×40 structural beam is 30 feet long. What is the total weight of this member?

A. 900 lb

B. 1,020 lb

C. 1,140 lb

D. 1,200 lb

47. An ironworker removes a 3/8-inch shim from a stack that was 7/8 inch thick. What is the remaining total shim thickness?

A. 1/2 in
B. 1/4 in
C. 3/8 in
D. 5/8 in

48. A storage bin has a volume of 432 cubic inches. What is this volume expressed in cubic feet?

A. 0.15 cu ft
B. 0.20 cu ft
C. 0.25 cu ft
D. 0.30 cu ft

49. A rectangular building bay measures 20 feet by 15 feet. What is the diagonal distance across the bay, used to verify that the bay is square during layout?

A. 18 ft
B. 22 ft
C. 25 ft
D. 28 ft

50. A steel angle member weighs 12.3 pounds per linear foot and is 24 feet long. What is the total weight of this angle?

A. 246.0 lb
B. 258.3 lb
C. 271.0 lb
D. 295.2 lb

51. A circular concrete pier has a diameter of 16 inches. What is the cross-sectional area of this pier in square inches? (Use π = 3.1416)

A. 201 sq in
B. 254 sq in
C. 314 sq in
D. 402 sq in

52. A steel beam can carry a maximum load of 48 kips. The current applied load is 36 kips. What percentage of the beam's rated capacity is being used?

A. 60 percent
B. 75 percent
C. 80 percent
D. 90 percent

53. A concrete footing is 4 feet long, 6 feet wide, and 2 feet deep. What is the volume of concrete needed for this footing in cubic feet?

A. 48 cu ft
B. 54 cu ft
C. 60 cu ft
D. 72 cu ft

54. A W12×45 beam is 25 feet long. What is the total weight of this structural member?

A. 975 lb
B. 1,050 lb
C. 1,125 lb
D. 1,200 lb

55. Headed shear studs are to be installed along a 32-foot beam at 12-inch on-center spacing, with a stud at each end. How many studs are required?

A. 29
B. 33
C. 37
D. 41

56. A 3,000-pound load is applied to a cantilever beam at 12 feet from the support. What is the bending moment at the support in foot-pounds?

A. 24,000 ft-lb
B. 27,000 ft-lb
C. 30,000 ft-lb
D. 36,000 ft-lb

57. Two column marks are located at 12 feet and 47 feet from the south end of a 60-foot beam. What is the distance between the two column marks?

A. 28 ft
B. 35 ft
C. 42 ft
D. 48 ft

58. When using oxyfuel cutting, an excess of oxygen in the cutting jet produces which visible characteristic in the cut surface?

A. A smooth, slag-free cut face with a bright blue tint from oxidized iron surface layers
B. Heavy black smoke at the cut face and incomplete separation of the metal along the cut line
C. A rough, gouged cut face with deep irregular striations from the excessively turbulent cutting jet
D. Heavy, persistent slag buildup that adheres to the bottom edge of the cut and is difficult to remove by chipping

59. A fillet weld symbol on a structural drawing shows the weld triangle below the reference line with the size marked to the left of the triangle. What does this location of the weld symbol indicate?

A. The fillet weld is on the arrow side of the joint — the side toward which the welding symbol's arrow points

B. The fillet weld is on the other side of the joint — the side opposite the arrow

C. The weld symbol below the reference line indicates a groove weld, not a fillet weld, regardless of the triangle shape

D. The size marked to the left of the triangle indicates that the weld is made from left to right along the joint length

60. Plasma arc cutting (PAC) differs from oxyfuel cutting primarily in that plasma arc cutting can cut which materials that oxyfuel cannot?

A. Structural carbon steel plates thicker than 4 inches, which exceed the practical limit for oxyfuel cutting torches

B. Coated or painted steel surfaces without requiring removal of the coating prior to cutting, unlike oxyfuel

C. Non-ferrous metals such as aluminum, stainless steel, and copper alloys, which cannot be oxyfuel-cut because they do not oxidize in the same way as carbon steel

D. Reinforcing bar (rebar) in concrete, using the plasma jet to burn through the concrete surrounding the bar before cutting the steel

61. Post-weld heat treatment (PWHT) is sometimes specified for structural welds. What is the primary purpose of PWHT on thick structural steel sections?

A. To add a corrosion-resistant oxide layer that eliminates the need for subsequent painting at the weld zone

B. To increase weld metal hardness by accelerating the grain growth in the weld heat-affected zone

C. To cure the weld flux chemically so that slag releases cleanly from the final weld bead surface

D. To relieve residual stresses in the weld and heat-affected zone, reducing the risk of hydrogen-induced cracking and distortion in thick, highly restrained sections

62. Low-hydrogen electrodes (E7018) must be stored in a rod oven after the original sealed container is opened. What oven temperature range is required to maintain these electrodes in a low-hydrogen condition?

A. Room temperature (65–75°F) in a sealed, moisture-proof container is sufficient after opening the original canister

B. 50–100°F above ambient temperature, in any enclosed heated cabinet, to keep moisture from condensing on the electrode coating

C. 250–300°F (121–149°C) in a dedicated electrode oven, as specified by AWS D1.1 and the electrode manufacturer for low-hydrogen maintenance

D. 500–600°F (260–316°C), which is the same temperature used for stress-relief heat treatment of the connected steel members

63. Flux-cored arc welding (FCAW) is often preferred over SMAW for field welding structural connections. What is the primary productivity advantage of FCAW over SMAW in this application?

A. FCAW uses DC positive polarity, which produces 15 percent deeper penetration per unit time than SMAW's AC polarity setting

B. FCAW uses a continuously fed wire electrode rather than a stick electrode, eliminating the downtime required to change electrodes and significantly increasing arc-on time per hour

C. FCAW requires no shielding gas in self-shielded formulations, eliminating the weight of gas cylinders and allowing unrestricted movement across the structure

D. FCAW welds cool more slowly than SMAW welds, producing a wider heat-affected zone that distributes stress more evenly and reduces the risk of cracking

64. Weld distortion — the warping of base metal as the weld cools — is caused by which fundamental physical process?

A. Differential thermal contraction: the weld metal and heat-affected zone heat up and expand during welding, then contract more than the surrounding cold metal as they cool, pulling the base metal toward the weld and causing angular distortion, camber, or bowing

B. Hydrogen embrittlement: hydrogen from the atmosphere enters the hot weld pool and causes internal cracking that deforms the surrounding plate as the cracks propagate

C. Galvanic corrosion between the filler metal and the base metal at the weld toe creates internal pressure that bends the surrounding plate

D. Residual mill-scale stress: pre-existing stress in the base metal releases during welding heat and causes the plate to spring to its stress-free shape

65. AWS D1.1 defines a set of 'prequalified' joint configurations that may be used without procedure qualification testing. What is the significance of a prequalified joint?

A. A prequalified joint has been inspected by a CWI on a prior project and carries over that approval to any subsequent project using the same configuration

B. A prequalified joint configuration has been shown by testing to reliably produce welds meeting D1.1 acceptance criteria when made by a qualified welder following the prescribed variables, and may be used without further procedure qualification testing

C. A prequalified joint is exempt from all welder qualification requirements, allowing any worker to make the weld without a certification card

D. Prequalified joints are approved only for non-structural applications; all structural joints in load-bearing connections require full procedure qualification testing regardless of joint geometry

66. Acetylene gas pressure in an oxyfuel welding or cutting system must never exceed a specific pressure. What is this maximum safe working pressure for acetylene, and why?

A. 50 psi maximum — above this pressure, the acetylene regulator cannot maintain stable flow and pressure fluctuations cause weld defects

B. 30 psi maximum — at pressures above 30 psi, acetylene becomes unstable and may dissociate explosively without any ignition source

C. 15 psi maximum — at pressures above approximately 15 psi (103 kPa), acetylene becomes unstable and may decompose explosively even without oxygen or ignition present

D. 100 psi maximum — a common misconception is that 15 psi is the limit, but the actual structural limit of acetylene cylinders is 100 psi at ambient temperature

67. For SMAW welding at 150 amperes, what is the minimum lens shade number recommended by ANSI Z87.1 / AWS for the welding helmet?

A. Shade 10 — the standard minimum for SMAW at currents from 100 to 200 amperes

B. Shade 8 — the minimum for low-amperage SMAW operations below 200 amperes

C. Shade 12 — the minimum for any SMAW operation regardless of current level

D. Shade 14 — the maximum shade required for SMAW and plasma operations at all currents

68. OSHA Subpart R requires that a steel column be guyed, braced, or otherwise supported during erection to prevent collapse. What is the minimum number of guys required per column, and in what arrangement?

A. One guy per column, anchored in the direction of the greatest expected wind load

B. Two guys per column, installed in opposite directions to resist wind from two directions

C. Three guys per column, arranged at 120-degree spacing to provide three-point stability

D. The minimum is determined by the competent person for each column based on its height, section, connections, and all anticipated loads and conditions

69. A layout crew establishes working points (WPs) offset from column centerlines so that layout control can be maintained after the structure is erected. What is the purpose of setting offset control points rather than marking the column centerlines directly?

A. Offset control points allow the surveyor to set up the instrument on the column centerline without interference from the column itself

B. Offset points reduce the likelihood that control marks will be covered by paint or concrete before all columns are set

C. OSHA requires all layout control marks to be offset from column faces to prevent marking on structural steel members

D. Offset control points allow layout marks to be placed in accessible, permanent locations that are not covered or disturbed by the column or its baseplate, maintaining a reliable reference throughout erection

70. A turnbuckle is used in a steel column guying system to adjust tension in the guy cable. The turnbuckle body is turned to shorten or lengthen the device. What inspection item on the turnbuckle is critical before the guy is tensioned?

A. The turnbuckle's barrel length must be measured to confirm it equals exactly one-third of the guy wire total length

B. The turnbuckle's jaw clevis pins must be confirmed to have their cotter pins installed so the pins cannot back out under load

C. The threads on both the jaw and hook ends of the turnbuckle must be checked for corrosion that could reduce their tensile strength below the required tension load

D. The turnbuckle must be pre-loaded to 50 percent of its rated load before installation to eliminate manufacturing slack from the threaded body

71. A column control point is set 5 feet east and 5 feet north of the column centerline. A layout ironworker uses a tape measure from the control point to locate the column mark. What is the diagonal distance from the control point to the column centerline?

A. 7.07 ft

B. 7.50 ft

C. 8.00 ft

D. 10.00 ft

72. A 'floating benchmark' is established on the structural steel frame during erection to transfer elevation to upper floors without requiring the surveyor to continually return to the original site benchmark. What is a critical limitation of a floating benchmark?

A. A floating benchmark cannot be set on structural steel because the steel deflects elastically under construction loads, making its elevation unreliable

B. Elevation errors accumulate with each transfer — a small error in the floating benchmark is magnified each time the elevation is transferred upward, making periodic checks against the original benchmark essential

C. Floating benchmarks are prohibited by OSHA because they are not permanently set in concrete and could be moved during structural steel operations

D. A floating benchmark can only transfer elevation downward; transferring elevation upward requires a separate method using a plumb bob and measured plumb distance

73. A laser plumb device projects a visible beam vertically upward from a base unit. What advantage does the laser plumb offer over an optical plumb instrument for transferring column centerlines to upper floors?

A. A laser plumb can be set up without a tribrach or leveling base, saving time compared to the careful leveling required for an optical plumb instrument

B. A laser plumb projects a visible reference point that two workers can read simultaneously at multiple floors, allowing concurrent layout on several levels without repositioning the instrument

C. A laser plumb instrument is not affected by air temperature variations that cause optical instruments to drift during the day, eliminating temperature correction factors

D. A laser plumb instrument can measure horizontal angles as well as vertical plumb, allowing a single setup to perform both column-plumbing and bay-layout tasks

74. After a column is set to grade (correct elevation) using leveling nuts on the anchor bolts, what is the purpose of the non-shrink grout placed under the column baseplate?

A. The grout chemically bonds the baseplate to the concrete footing, preventing the column from being lifted off the footing by uplift forces from wind

B. The grout fills the gap between the baseplate and the concrete footing, providing full uniform bearing support for the baseplate's dead and live loads once the leveling nuts are backed off — or left in place — per the engineer's design

C. The grout provides temporary support for the column during erection and is chipped out and replaced with concrete after the column is plumbed and guyed

D. The grout protects the leveling nuts from corrosion by encasing them in a waterproof cementitious material after the column is aligned

75. A metal roof deck must drain water toward the low-framing edge. The drainage slope is specified at 1/8 inch per foot. Over a 100-foot roof span, what is the total vertical drop required for proper drainage?

A. 8.0 in

B. 9.5 in

C. 10.0 in

D. 12.5 in

76. When a column is being brought to final alignment after guying, the column's web must be oriented parallel to the column line on the drawings. Which tool is used to verify that the web is in the correct rotational position?

A. A 4-foot spirit level placed against the web face to confirm the web is plumb in the plane perpendicular to the flanges

B. A plumb bob hung from the top flange tip and referenced against a chalk line on the floor showing the correct web plane

C. A magnetic angle finder (digital level) placed on the column web to read the angular deviation from the column-line bearing shown on the drawings

D. A theodolite set on the column baseline, sighting along the column web to confirm alignment with the building grid azimuth

77. A structural connection detail shows a circle with an X through it centered on the bolt hole location. What does this standard symbol indicate?

A. A high-strength bolt in a standard round hole, indicating the bolt is a permanent structural fastener subject to the project's bolt inspection requirements

B. A countersunk flathead bolt, where the X indicates the machined countersink angle for the bolt head

C. An erection pin or drift pin hole, which is temporarily used during erection and will be filled with a permanent bolt after alignment

D. A plug weld, where the hole is to be filled with weld metal after assembly to transfer load between the connected plies

78. A structural steel project has three types of drawings: design drawings, shop drawings, and erection drawings. Which drawing type does the ironworker use most directly in the field, and what information does it contain?

A. Design drawings — these show every dimension and connection detail the ironworker needs, and shop drawings are only for the fabricator's internal use

B. Shop drawings — the fabricator issues shop drawings to the ironworker showing each piece with its mark number and dimensions, but erection drawings show the overall layout

C. Erection drawings — these show the layout and placement of all structural members in the finished structure, including member mark numbers that match the marks on the steel itself, column line dimensions, elevations, and connection details specific to the field assembly

D. Inspection drawings — a separate set issued by the special inspector showing the locations where weld and bolt inspections are required

79. A column schedule on the structural drawings lists columns by their marks (C1, C2, C3, etc.) and provides which information for each column?

A. The column's position in the erection sequence, the crane picks required, and the predicted plumb tolerance after guying

B. The column's designation (section size), material specification, length, splice locations, and connection details for each connection point — allowing the fabricator and ironworker to understand exactly what each column requires

C. The column's exact field-measured plumb deviation from the baseline survey, used for calculating the column's lateral displacement under wind load

D. The column's paint system and coating thickness requirements, used by the painting contractor to specify the primer and topcoat materials

80. A bolted connection detail in a structural drawing uses a bolt call-out notation '1-1/8" Ø A325 SC.' What does 'SC' in this notation indicate?

A. 'SC' stands for 'Standard Chamfer,' indicating that the bolt holes require chamfered edges for the bolt head to seat properly

B. 'SC' stands for 'Self-Clinching,' a proprietary fastener type used in pre-engineered metal building connections

C. 'SC' stands for 'Single Cut,' indicating the bolts are trimmed to a short grip length for the specific connection thickness

D. 'SC' stands for 'Slip Critical,' indicating that these bolts must be fully pretensioned in a Class A or Class B faying surface connection that resists service load by friction rather than bearing

81. During structural steel erection, the ironworker notices that the architectural drawings show a wall opening that conflicts with a structural beam location shown on the structural drawings. What is the correct course of action?

A. Follow the structural drawings because structural members always govern over architectural elements — the opening can be relocated by the wall contractor after the steel is in place

B. Follow the architectural drawings because the finished building must meet the architect's design intent, and structural members can be relocated in the field to avoid openings

C. Stop erection at the conflict location, report the discrepancy to the superintendent or engineer of record immediately, and await resolution before placing the conflicting member

D. Use the combined average dimension of the two conflicting drawings as the governing location for the beam until a formal correction is issued

82. A weld symbol's tail contains the notation 'AWS D1.1 PREQUALIFIED.' What instruction does this tail notation give the welder?

A. The tail notation means the weld was previously inspected and accepted, and no further inspection is required for this weld location

B. The tail notation identifies the approved weld procedure specification (WPS) number that the welder must use for this joint

C. The tail notation indicates the location in the drawing set where the weld detail section can be found on the referenced detail sheet

D. The tail notation specifies that this joint must be made using a prequalified joint design per AWS D1.1, and the applicable prequalified welding procedure specification for that joint geometry and material combination governs the weld parameters

83. A structural plan view shows a symbol consisting of a circle at the intersection of two column lines, with the designation 'A1' inside the circle. What does this symbol identify?

A. The type of connection hardware required at this location — A1 identifies an A-type connection with 1 bolt row

B. The column erection sequence number — column A1 must be the first column erected in the erection plan

C. The column mark 'A1' — the intersection of column line A and column line 1 — identifying the column at that grid intersection, consistent with the column and grid layout conventions

D. The anchor bolt group designation — A1 indicates the first anchor bolt group poured in the concrete sequence

84. Bar joist end bearing seats must bear on the supporting structural member by a minimum distance. What is the minimum required bearing length for K-series joists on structural steel, per SJI specifications?

A. 2-1/2 inches minimum bearing on steel, measured from the face of the support to the end of the joist seat

B. 3 inches minimum bearing on steel, which accounts for construction tolerances in beam placement and joist length

C. 4 inches minimum bearing on steel, matching the standard bearing for steel members on concrete supports

D. The minimum bearing is 1-1/2 inches on steel; 2-1/2 inches is required on concrete and masonry supports

85. DLH-series (Deep Longspan) bar joists are used for the longest spans in the SJI joist families. Which span range does the DLH-series cover?

A. LH-series and DLH-series are identical in span range; the DLH designation applies to special-order sections not in the SJI catalog

B. DLH-series joists span from 89 to 240 feet, making them the longest-spanning bar joist family in the SJI catalog

C. DLH-series joists span from 60 to 120 feet, complementing the LH-series that covers up to 96 feet

D. DLH-series joists span from 30 to 89 feet, filling the gap between K-series and LH-series for medium-length spans

86. A joist girder transfers the reactions from the bar joists framing into it to the supporting columns. How is the joist girder's top chord loaded differently from a standard bar joist's top chord?

A. A joist girder's top chord carries only axial compression, the same as a standard bar joist; the joist girder is just a larger section

B. A joist girder's top chord carries bending in addition to axial compression because the panel point loads from the bar joists create beam-bending moments between the vertical web members

C. A joist girder's top chord carries tension rather than compression because the girder's greater depth reverses the stress state in the upper chord

D. A joist girder carries concentrated panel-point loads from bar joists at discrete intervals rather than uniformly distributed load, creating local top-chord bending between web members in addition to axial truss chord forces

87. OSHA 1926.757(a)(1) requires that bar joists be secured at both ends before any other load is applied. What additional anchoring requirement applies to the ends of bar joists at exterior walls?

A. Joist ends at exterior walls must be provided with end anchors — typically welded clips or bent bars — that restrain the joist end from lateral movement and satisfy the lateral anchorage requirement at the bearing

B. Joist ends at exterior walls must be bolted with a minimum of two 3/4-inch bolts in a double-angle connection that resists both gravity and lateral wind loads

C. End anchors at exterior walls are optional if the joist bridging is installed and bolted within 4 hours of joist placement

D. Joist ends at exterior walls must be welded to a continuous edge angle that spans between columns along the perimeter to transfer diaphragm forces

88. Diagonal bridging for bar joists must terminate at specific structural elements called 'bridging terminus points.' What qualifies as an acceptable bridging terminus point?

A. Any bar joist in the system qualifies as a bridging terminus point, because bridging forces are resisted by the combined weight of the joist system

B. Bridging terminus points are defined intervals of 12 feet along the row of bridging, where all diagonal bridging forces are assumed to self-cancel

C. An acceptable bridging terminus point is a structural member capable of resisting the cumulative lateral force from all bridging lines connecting to it — typically a wall, column, or designated structural frame element that is connected back to the building's lateral load-resisting system

D. Bridging terminus points are required only for LH and DLH series joists; K-series bridging forces are small enough to be resisted by the joist seats alone

89. Direct Tension Indicators (DTIs) are load-indicating washers used to verify bolt pretension. How does the ironworker confirm that the bolt has reached minimum pretension when using a DTI?

A. When a feeler gauge of the specified thickness can no longer be inserted into the DTI gap at 50 percent of the DTI's protrusions, the minimum pretension has been achieved in that bolt

B. When the DTI's protrusions have been completely flattened by the tightening force, confirming that the bolt clamp force equals the DTI's rated closing force

C. When the DTI changes color from silver to gold, indicating that the tension in the bolt has exceeded the chemical threshold for the indicator coating

D. When the nut face is flush with the top surface of the DTI washer, indicating that the full bolt shank elongation has been achieved

90. ASTM A490 bolts are stronger than A325 bolts at the same diameter. When must A490 bolts be used rather than A325 bolts?

A. A490 bolts must be used whenever the bolt diameter exceeds 1 inch, because A325 is not available in diameters larger than 1 inch

B. A490 bolts are required for all seismic connections in Seismic Design Categories D, E, and F, regardless of the computed bolt demand

C. A490 bolts are used when the structural engineer has designed the connection based on A490's higher pretension and tensile strength — when the required bolt shear or tension capacity exceeds what A325 can provide at the available diameter

D. A490 bolts must be used for all connections in slip-critical applications; A325 bolts are permitted only in bearing-type connections

91. AISC Specification Section J3.1 requires a pre-installation verification test for fastener assemblies before use. What does this test verify?

A. That the bolts are within the specified dimensional tolerances and will fit through the holes in the connection plates without modification

B. That the bolts meet the minimum tensile strength marked on the bolt head by testing each heat lot with a pull tester in the field

C. That the fastener assembly (bolt, nut, and washer from the specific lot) will develop the required pretension when tightened using the specified method on the actual job site, accounting for lubrication, thread fit, and field conditions

D. That the bolts are not counterfeit by verifying the manufacturer's identification marking against the certified mill test report for the lot

92. High-strength bolts in short-slotted holes parallel to the direction of load must be installed with a hardened washer under which element, and why?

A. Under the bolt head only, to prevent the bolt head from bearing directly on the slot edge and bending the bolt shank

B. Under both the nut and bolt head when either element bears over a slotted hole, to bridge the slot and prevent the fastener from pulling through under tensile load

C. Under the nut only, because the bolt head is always on the outer face of the connection and does not contact the slot

D. No washer is required in slotted holes — the bolt head and nut face areas are large enough to bridge the slot without additional bearing area

93. An ironworker's spud wrench (also called an alignment bar or ironworker's bar) serves two primary functions on the steel erection site. What are these two functions?

A. It is used as a pry bar to separate stuck structural members and as a hammer to drive connection bolts into holes

B. It aligns bolt holes by inserting the tapered tip into misaligned holes to draw them into alignment, and the hex-head wrench end tightens the connection bolts to snug-tight during erection

C. It is used to test the hardness of connection steel by striking the surface and measuring the rebound, and to mark bolt locations by scribing through the holes

D. It provides a temporary anchor point for safety lanyards and doubles as a measuring tool, with the body graduated in 2-inch increments

94. An electric impact wrench and a pneumatic impact wrench are both available for structural bolt tightening. Which operational characteristic is specific to electric impact wrenches compared to pneumatic?

A. Electric impact wrenches can only run at a single speed, while pneumatic wrenches allow variable speed control by adjusting the air supply pressure

B. Electric impact wrenches generate less torque than pneumatic wrenches of comparable size, limiting their use to bolts smaller than 3/4 inch diameter

C. Electric impact wrenches have programmable torque shutoff settings that allow the operator to set a specific stop point, making them more suitable for applications requiring repeatable torque measurement

D. Electric impact wrenches require less maintenance than pneumatic wrenches because they have no internal lubrication system and no air filter or oiler to service

95. An annular cutter (hole saw) is used in a magnetic base drill rather than a twist drill bit. What is the primary advantage of an annular cutter over a twist drill for making bolt holes in structural steel?

A. An annular cutter removes only the outer ring of material to create the hole, leaving a solid core plug that is ejected; this requires significantly less force and energy than a twist drill that must remove all material in the hole area

B. An annular cutter produces a smoother hole surface than a twist drill, eliminating the need for reaming before bolt installation in structural connections

C. An annular cutter can be used without a magnetic base drill; it is compatible with any standard drill press or hand-held drill motor

D. An annular cutter is interchangeable with the plug cutter used by carpenters, so the same tool can be used for both steel and wood connections on the same project

96. An oxygen lance (burning bar or exothermic lance) uses a steel tube filled with iron rods to create an extremely hot cutting flame when oxygen is blown through the ignited tube. For which material is an oxygen lance most useful compared to a standard oxyfuel cutting torch?

A. Stainless steel — the oxygen lance produces less ultraviolet radiation than oxyfuel torches, protecting the chrome content of stainless from UV degradation during cutting

B. Carbon steel plate thicker than 6 inches — the oxygen lance achieves higher cutting speeds than an oxyfuel torch on thick plates

C. Galvanized structural steel — the oxygen lance burns off the zinc coating before the cutting flame reaches the base metal, preventing zinc vapor inhalation

D. Concrete and masonry — the oxygen lance's extreme temperature (approximately 8,000°F) can burn through reinforced concrete and masonry that would stop an oxyfuel cutting torch

97. Headed shear studs can be welded to structural steel beams either directly to the beam flange (direct-to-beam) or through the metal deck in a single through-deck weld cycle. What limitation applies to through-deck stud welding?

A. Through-deck stud welding is limited to studs with a shank diameter of 3/4 inch or less, because the arc cannot sustain the heat to weld larger studs through deck material

B. Through-deck stud welding is limited to composite floor deck only; through-deck welding is prohibited on roof deck because the deck rib geometry prevents the stud gun from seating properly

C. Through-deck stud welding is permitted for all stud diameters when the total deck thickness (including any overlapping sheets) does not exceed 3/4 inch over the beam flange, per AWS D1.1 requirements

D. Through-deck stud welding produces welds rated at only 75 percent of direct-to-beam weld capacity and requires twice as many studs to achieve the same composite action

98. Metal deck sheets along the diaphragm boundary (perimeter beams and drag struts) require closer-spaced fastening than deck in the interior field of the bay. Why is closer fastener spacing required at the diaphragm boundary?

A. Perimeter beams carry heavier gravity loads than interior beams, so the deck must be more securely attached to prevent uplift from the higher beam deflection

B. The diaphragm boundary is the zone where accumulated in-plane (shear) forces from wind and seismic loads are transferred from the floor or roof deck into the supporting beam, requiring greater shear transfer capacity than the interior field region

C. Closer fastener spacing at the boundary prevents deck sheets from peeling back from the perimeter beams during crane picks of adjacent structural members

D. OSHA Subpart R requires closer deck-to-steel attachment within 6 feet of all open edges to prevent deck sheet uplift during elevated-work fall protection activities

99. SDI Diaphragm Design Manual divides the deck fastening pattern into zones: field of the deck versus perimeter zones. What governs the required fastener density in each zone?

A. Fastener density is uniform across all zones; the zone designations only indicate which fastener type (puddle weld vs screw) is required in each zone

B. Zone fastener density is based on the deck sheet weight per linear foot — heavier deck profiles require more fasteners to support their own weight during erection

C. Fastener density in each zone is determined by the calculated in-plane shear demand at that location from the diaphragm analysis, with perimeter and edge zones carrying higher shear demands that require closer fastener spacing

D. Zone designations in SDI are only for roof deck; floor composite deck uses a uniform fastener spacing across the entire bay regardless of location

100. Composite metal floor deck has a formed rib profile that runs in one direction. When the deck ribs run perpendicular to the composite beam span, what special installation detail is required at the sheet end laps?

A. Sheet end laps perpendicular to the beam must have a minimum 12-inch overlap rather than the standard 3-inch end lap, to prevent the rib profile from creating a step in the concrete surface

B. Where deck ribs are perpendicular to the beam, sheet ends must be lapped over the beam flange and both sheets fastened through to the steel — not lapped between beams — to ensure the end-lap connection has adequate bearing support beneath it

C. Perpendicular deck ribs require that alternating sheets be inverted so the ribs nest with each other at the end lap, reducing the slab thickness variation at lap locations

D. When deck ribs are perpendicular to the composite beam, the deck is set with the closed (bottom) side facing up so that the ribs serve as a formed trough for the concrete rather than a standard pan-deck profile

Practice Exam 4: Answer Key and Explanations

1. B — Rotation-resistant wire rope has opposing outer and inner strand layers, generating torques that cancel each other internally. This prevents net rope torsion from spinning the load. Standard 6x19 rope transfers rotational torque directly to the load. The opposing-lay construction is critical in crane applications where load spin creates hazards for workers below the hook.

2. D — In a four-leg bridle sling the master link carries the full total load. Each leg carries a fraction based on sling angle and geometry. The capacity check per leg must use the angle factor for that leg's specific angle. The most steeply angled or lightest-rated leg governs the entire assembly's safe working capacity.

3. A — A kink permanently displaces wires and strands from their designed positions, destroying the rope's load-carrying geometry and concentrating stress at the kinked location. ASME B30.9 requires immediate removal from service — there is no repair or downgrade procedure for kinked wire rope. The internal damage remains even if the visible bend is straightened by hand after the kink forms.

4. C — Choker hitch capacity = 75 percent of vertical rating = 0.75 x 12,000 = 9,000 lb. Option A (6,000) is 50 percent; B (8,400) is 70 percent; D (12,000) is the unreduced vertical rating. Option A (6,000) is 50 percent; B (8,400) is 70 percent; D (12,000) is the unreduced vertical rating.

5. A — A bolt-type (safety) shackle has a bolt with a nut and cotter pin that prevents the pin from backing out under cyclic loading or load rotation. A screw-pin shackle's threaded pin can unscrew when the load rotates or under repeated loading cycles, allowing the pin to fall out and the rigging to release.

6. B — The fleet angle is the angle between rope centerline and drum center groove. For smooth drums the maximum is 2 degrees; for grooved drums 3.5 degrees. Exceeding these limits causes rope to bunch on one side, creating uneven layer winding, accelerated drum flange wear, and damage as rope crosses previously wound layers.

7. D — Line pull (ignoring friction) = load / parts of line = 7,500 / 3 = 2,500 lb. Three parts of line supporting the lower block provides a 3:1 mechanical advantage, so the running line must exert one-third of the total load weight. Option A (1,500) requires 5 parts; B (1,875) requires 4 parts; C (2,250) requires 3.33 parts.

8. C — The ASME/WSTDA synthetic round sling color code specifies blue for 6-ton (13,200 lb) vertical rated capacity. The capacity sequence increases from purple (1 ton) through green, yellow, tan, red, white, orange, and blue. Blue slings are common in structural steel rigging where loads in the 10,000-14,000 lb range are typical.

9. B — When a load's center of gravity is not centered between the pick points, the sling legs on the heavier side carry more tension than those on the lighter side. The load tilts until the CG is directly below the crane hook, with the heavier side lower and the lighter side higher.

10. C — For 6x19 classification wire rope in running-line service, ASME B30.9 requires removal when 12 or more wires are broken in one lay length, or when 4 or more wires are broken in one strand in one lay length. Option A (3) is too conservative; B (6) applies to certain stationary rope applications.

11. D — Standard carbon-steel eyebolts are significantly derated for angular loading. At 45 degrees from vertical, the manufacturer's table typically reduces capacity to 30 percent or less of the vertical rating because the bent shank experiences combined tension and bending stress. Shoulder eyebolts with a machined load-rated shoulder are required when angular loading is anticipated.

12. A — The minimum recommended included angle at the choke point of a choker hitch is 120 degrees. At angles below 120 degrees, the bending radius at the choke becomes small enough to impose additional stress on the sling beyond what the standard 75 percent reduction factor accounts for, reducing the effective capacity further.

13. B — Tension per leg = (total load / 2) × sling angle factor = (20,000 / 2) × 1.155 = 10,000 × 1.155 = 11,550 lb per leg. The sling angle factor is applied per leg to the load each leg must carry (half the total for a symmetric two-leg bridle).

14. A — When the shackle bow is too narrow for the sling eye, the eye contacts the shackle pin rather than seating in the curved bow. The pin is designed to carry the shackle's rated load in bending when properly supported by both the jaw and the eye seated in the bow.

15. C — Tension per leg = load divided by (2 x sin 30 degrees) = 6,000 divided by (2 x 0.5) = 6,000 divided by 1.0 = 6,000 lb. At 30 degrees from horizontal, sin equals 0.5, so each leg carries a tension equal to the full load weight. At 30 degrees from horizontal.

16. A — A spreader bar (lifting beam) holds sling attachment points apart at a fixed spacing, preventing sling legs from converging toward the load's center under horizontal sling tension. Without a spreader, bridle sling legs slide inward along a smooth cylindrical load, potentially concentrating at one point and creating a single-leg pick rather than a balanced two-point lift.

17. A — In an asymmetric lift, the lighter (higher) side requires a longer sling leg to bring that side up to the same elevation as the heavier (lower) side. A longer sling leg on the lighter side means that side's attachment point on the load is lower, effectively raising that end of the load when the crane hook lifts.

18. D — A kinked wire rope cannot be straightened or repaired. The permanent distortion at the kink displaces individual wires from their designed geometric positions, creating stress concentrations that remain even if the visible bend is straightened. Under load, the kinked wires carry disproportionate stress because the rope's cross-section no longer distributes load uniformly.

19. A — OSHA 1926.1412(d)(1) requires load weight to be established before each lift using engineering calculations, certified weight data, or other reliable documented means. A stamped lift plan with calculated load weights from structural drawings and material specifications is an acceptable confirmed weight source. Truck weight subtraction, visual estimation, and using the hook indicator.

20. D — OSHA 1926.1427 requires crane operators to be certified by an accredited testing organization or qualified through an equivalent employer program. NCCCO requires both written and practical examinations specific to the crane type. Manufacturer training courses, CDL endorsements, and hours-of-experience records alone do not satisfy the standard. The certification must demonstrate knowledge and.

21. D — OSHA 1926.1431(g) requires a trial lift before each personnel hoist. The loaded platform is raised approximately 2-3 feet, held for 5 minutes, swung through the full working arc, and inspected for any deficiency before personnel are hoisted to elevation. Option C describes a proof-load test — a separate requirement. The trial lift.

22. C — OSHA 1926.1404 requires a competent person to direct assembly and disassembly. When the manufacturer's procedures require technical expertise beyond the competent person's knowledge, a qualified person with that specific training must also be present. The competent person handles general safety oversight while the qualified person manages the technical assembly procedure for the specific crane make and model being erected.

23. C — Working radius is measured horizontally from the crane's axis of rotation (the center of the slewing ring) to the center of the vertical hoist line at the hook, with the load applied. This horizontal distance is the key variable in the load chart because it determines the load moment (load × radius) that the crane's structure must resist.

24. B — A fixed jib attached to a lattice boom tip extends the crane's horizontal reach and hook height beyond the main boom alone. The jib is a lighter secondary member operating at a fixed angle. Because the jib places its load at the tip of the main boom, rated capacity at the jib.

25. B — Line pull = load / parts of line = 15,000 / 5 = 3,000 lb. With 5 parts of line, the mechanical advantage is 5:1 and the running line needs to exert one-fifth of the total load. Option A (2,500) requires 6 parts; C (3,500) requires approximately 4.3 parts; D (4,000) requires 3.75 parts.

26. D — All-terrain cranes are multi-axle machines engineered for highway travel at road-legal speeds, with all-wheel steering and independent suspension for both on-road efficiency and off-road stability.

Rough-terrain cranes have a single-engine, single-cab design optimized for rough off-road movement at low speeds, typically 20–25 mph maximum, and are not engineered for highway travel.

27. A — Dynamic loading occurs when a crane accelerates a load upward or decelerates it during lowering. Newton's second law requires a net upward force to accelerate the load's mass, adding to the static hook load during acceleration. During hoisting, the dynamic hook load = static load × (1 + a/g), where a is acceleration and g is gravity.

28. C — A tower crane mast foundation must transfer all load components simultaneously: vertical compression from the crane and hook load, vertical tension from counterweight overturning when the hook load is small, horizontal shear from wind and dynamic forces, and overturning moments from the load-moment combination. The foundation must be designed for all combinations.

29. A — A crawler crane's tracks provide full ground contact along the entire length of each track, creating a wide, stable base. The effective tipping fulcrum is at the outer edge of the track, far from the crane's centerline. A rubber-tired mobile crane on outriggers also achieves a wide base but depends on four-point outrigger contact rather than full-length track contact.

30. C — When a thunderstorm approaches, OSHA 1926.1415(b) requires the crane to be secured per the manufacturer's procedures, which typically include lowering the load to the ground, lowering or securing the boom, and evacuating to shelter before lightning is in the immediate area. Waiting for visible lightning before acting is too late; modern weather monitoring allows earlier warning.

31. B — The boom hoist rope holds the boom at the correct angle and carries both the boom weight and reaction forces from the hook load. An undersized boom hoist rope has lower breaking strength than required. Without the boom hoist rope's structural support the boom cannot maintain its designed angle under the combined.

32. A — Two-blocking occurs when the load block is hoisted until it contacts the boom tip sheaves, bypassing the mechanical advantage of the sheaves and placing the rope in direct tension between the drum and the boom tip. Further hoisting can exceed the rope's breaking strength or pull the boom tip off, causing catastrophic failure.

33. A — The forklift's nameplate capacity of 5,000 lb is rated at a 24-inch load center. When the actual load center is 36 inches, the increased moment arm creates a larger tipping moment for the same load. The manufacturer's load center capacity chart shows the rated capacity at the actual 36-inch center, which will be less than 5,000 lb.

34. D — Column twist — rotation about the vertical axis — is corrected by applying a controlled rotational force at a lever arm on the column web or flange using an ironworker's bar, while the anchor bolt nuts hold the base in place. A magnetic angle gauge or digital inclinometer on the web shows the angular deviation from the required bearing.

35. C — Temporary bracing resists lateral loads that the frame cannot resist on its own before the permanent lateral load-resisting system is complete. Removing bracing before the permanent system is

in place removes the only load path for lateral forces, which can cause the unbraced frame to collapse under wind or construction loading.

36. B — Through-deck stud welding allows studs to be installed after deck placement by burning through the deck material and fusing the stud base to the beam flange in a single drawn-arc cycle. The stud gun seats the ferrule against the deck surface and the arc burns through the thin deck material. Direct-to-beam welding before deck placement is also acceptable.

37. B — Number of bolts = rows multiplied by bolts per row = 4 x 3 = 12 bolts. Option A (9) equals 3 rows x 3; C (15) equals 5 rows x 3; D (18) equals 6 rows x 3. Accurate reading of bolt patterns from structural drawings is critical for material take-off.

38. C — The deck-to-beam attachment is not just a construction convenience — it is the structural connection that allows the floor deck to act as a horizontal diaphragm. In-plane shear forces from wind and seismic loads are collected by the floor deck and transferred through the fasteners to the supporting beams, then to the building's vertical lateral force-resisting system.

39. D — OSHA 1926.756(c) requires column splices to be located at least 4 feet above the floor below and not less than 12 inches above the highest decked level at that tier. This placement keeps the splice above the working deck level, provides connector access, and reduces the risk of the splice falling in the zone of maximum lateral sway.

40. A — OSHA 1926.752(e) prohibits ironworkers from working alone during structural steel erection. At least two ironworkers must be present so that if one is injured, the second can summon help. Structural ironworking involves falls, suspended load hazards, and crush risks from shifting members — all far more dangerous to a solo worker who has no colleague available to provide immediate assistance.

41. A — Partial composite action requires a minimum number of shear studs equal to the composite ratio times the full-composite stud count. At 50 percent composite: 0.50 × 32 = 16 studs required. AISC 360 Section I8.2a requires a minimum of 25 percent composite (not 50%), so 50 percent is above the code minimum.

42. B — Pre-engineered metal building members are designed as efficient thin-web sections weighing less than conventional steel at comparable spans and loads. Their thin webs and flanges are more susceptible to local bending and distortion if rigging exerts concentrated point loads during handling. Rigging plans must use spreader bars to distribute pick forces along.

43. D — AISC Code of Standard Practice Table 7.13 permits a beam top-of-steel elevation tolerance of plus or minus 1/4 inch at column locations. This tolerance accounts for normal fabrication and erection variations. At the column — the critical bearing point — the tight 1/4-inch limit ensures connection compatibility and correct deck elevation for the finished floor or roof system.

44. C — Tack welds incorporated into final welds are not truly temporary — they become part of the finished weld. AWS D1.1 Clause 5.18 requires that tack welds to be incorporated into final welds meet the same quality standards as production welds, including minimum size per base metal thickness, made by a qualified welder, using a prequalified or qualified procedure.

45. B — OSHA 1926.756(a)(1) requires a minimum of two bolts per connection — installed at opposing ends — before any additional load is applied or the connector moves to another connection. Two bolts prevent the connection from pivoting about a single bolt and maintain the member's position while the bolt-up crew follows with remaining bolts.

46. D — A W16×40 designation means the beam weighs 40 pounds per linear foot. Total weight = 40 × 30 = 1,200 lb. Option A (900) uses 30 lb/ft; B (1,020) uses 34 lb/ft; C (1,140) uses 38 lb/ft. The weight per linear foot is always the number after the × in the W-shape designation.

47. A — 7/8 minus 3/8 = 4/8 = 1/2 inch. Both fractions share the same denominator, making the subtraction direct. Option B (1/4) would result from removing 5/8 from 7/8; C (3/8) is the removed shim's own thickness; D (5/8) results from removing a 2/8 shim. Shim arithmetic is performed frequently in column alignment work when adjusting elevations by measured fractional-inch increments.

48. C — There are 1,728 cubic inches in one cubic foot (12 x 12 x 12 = 1,728). 432 divided by 1,728 = 0.25 cubic feet. Option A (0.15) uses an incorrect conversion factor; B (0.20) corresponds to 2,160 cubic inches per cubic foot; D (0.30) uses 1,440 per cubic foot. Unit conversion between.

49. C — Diagonal = $\sqrt{(20^2 + 15^2)} = \sqrt{(400 + 225)} = \sqrt{625} = 25$ feet. This is a scaled 3-4-5 right triangle (15 = 3 × 5, 20 = 4 × 5, 25 = 5 × 5). Recognizing the 3-4-5 pattern confirms the result without needing a calculator. Equal diagonals of 25 feet confirm the bay is square during layout.

50. D — Total weight = weight per linear foot x length = 12.3 x 24 = 295.2 lb. Option A (246.0) uses 10.25 lb/ft; B (258.3) uses 10.76 lb/ft; C (271.0) uses 11.29 lb/ft. Weight per foot for rolled sections is found in the AISC section property tables; accurate table reading is essential for crane capacity planning before each pick.

51. A — Area = pi x r squared = 3.1416 x (16/2) squared = 3.1416 x 64 = 201.1 sq in. Option B (254) uses r = 9; C (314) uses r = 10; D (402) uses r approximately 11.3. Using the diameter directly without halving it is the most common error in circular area calculation.

52. B — Percentage of capacity = (applied load divided by rated capacity) x 100 = (36 / 48) x 100 = 75 percent. Option A (60%) corresponds to 28.8 kips; C (80%) to 38.4 kips; D (90%) to 43.2 kips. Knowing the percentage of capacity in use determines when a critical lift plan is.

53. A — Volume = length × width × depth = 4 × 6 × 2 = 48 cubic feet. Option B (54) would require a 4 × 6 × 2.25 footing; C (60) a 4 × 6 × 2.5; D (72) a 4 × 6 × 3. All dimensions are already in feet, so no unit conversion is needed before multiplying.

54. C — A W12x45 designation means the beam weighs 45 pounds per linear foot. Total weight = 45 x 25 = 1,125 lb. Option A (975) uses 39 lb/ft; B (1,050) uses 42 lb/ft; D (1,200) uses 48 lb/ft. The weight per foot is always the number after the x in a W-shape designation.

55. B — Number of studs = (beam length in inches / spacing) + 1 = (32 × 12 / 12) + 1 = 32 + 1 = 33 studs. Adding 1 accounts for the stud at the starting end — a stud at each end of the beam means there is always one more stud than the number of spaces.

56. D — Bending moment at the support = force × distance = 3,000 lb × 12 ft = 36,000 ft-lb. For a cantilever beam, the maximum moment is at the fixed support and equals the applied load times the distance from the support to the load. Option A (24,000) uses 8 ft; B (27,000) uses 9 ft; C (30,000) uses 10 ft.

57. B — Distance between column marks = 47 − 12 = 35 feet. Option A (28) and C (42) are incorrect subtractions; D (48) is the distance from the second mark to the far end. Layout distances between two known reference points are calculated by subtracting the smaller measurement from the larger.

58. D — Excess oxygen in the oxyfuel cutting jet produces heavy, persistent slag that adheres to the bottom edge of the cut kerf and is difficult to remove by chipping. The correct oxygen pressure is set per the torch manufacturer's specifications for the material thickness. Setting the correct oxygen pressure per the manufacturer's specification.

59. A — In AWS welding symbol notation, a symbol placed below the reference line indicates an arrow-side weld — the side the arrow points toward. A symbol above the reference line indicates the other side. This convention is fundamental to reading structural weld symbols correctly. This arrow-side versus other-side distinction is fundamental to correctly.

60. C — Oxyfuel cutting relies on the rapid oxidation of iron when heated to ignition temperature and exposed to a high-pressure oxygen jet. Non-ferrous metals like aluminum, stainless steel, and copper alloys do not oxidize in the same way — they either form stable oxide films that prevent further oxidation or melt before reaching the required iron oxidation temperature.

61. D — PWHT heats the completed weld and heat-affected zone to a controlled temperature (typically 1,100–1,200°F for structural carbon steel) and holds it there, then cools it slowly. This thermal cycle allows residual stresses from weld solidification and cooling to relax through plastic deformation at the lower yield strength at elevated temperature.

62. C — AWS D1.1 and electrode manufacturers require low-hydrogen electrodes to be stored at 250-300 degrees F after opening the original sealed container. Moisture absorbed by the low-hydrogen coating at room temperature increases weld hydrogen content, defeating the purpose of using these electrodes. Electrodes stored at room temperature after opening are limited to a.

63. B — The primary productivity advantage of FCAW over SMAW is the continuously fed wire electrode from a spool, eliminating the 15-30 second interruptions required to change SMAW stick electrodes every 12-18 inches of weld. The continuously fed wire electrode also increases deposition rate and arc-on time significantly compared to the stick electrode changes required for SMAW.

64. A — Weld distortion results from differential thermal contraction. The weld metal and heat-affected zone heat to high temperatures and expand. As they cool, they contract more than the surrounding cold base metal, which acts as a rigid restraint. The restrained contraction generates residual tensile stress in the weld zone and compressive stress in the adjacent plate.

65. B — A prequalified joint in AWS D1.1 is a joint geometry and welding variable combination that has been demonstrated through testing to reliably produce welds meeting the code's mechanical property

requirements. A qualified welder following the prequalified WPS for that joint may make the weld without further procedure qualification testing. This reduces cost and setup time for common joint configurations.

66. C — Acetylene becomes unstable above approximately 15 psi gauge pressure. Above this threshold, acetylene can decompose explosively — splitting into carbon and hydrogen — without requiring oxygen or an ignition source. Acetylene cylinders contain acetylene dissolved in acetone at approximately 250 psi, but working pressure to the torch must never exceed 15 psi in the system.

67. A — ANSI Z87.1 and AWS A6.2 specify lens shade 10 as the standard minimum for SMAW at currents from 100 to 200 amperes. At 150 amperes, shade 10 provides adequate protection against ultraviolet, infrared, and visible arc radiation. Shade 8 is used for low-amperage TIG welding; shade 12 is for higher-amperage applications.

68. D — OSHA 1926.754(b)(1) does not specify a fixed minimum number of guys per column. It requires a competent person to determine the guying requirement for each specific column based on its height, section, connections, weight, site wind exposure, and erection sequence. Some short columns may need no guying; tall, slender columns may need four or more.

69. D — Offset control points are placed at measured distances from column centerlines in accessible, permanent locations that remain clear of the column and its baseplate. Once the structure is erected, column centerlines are inaccessible without climbing. Permanent offset marks allow layout crews to re-establish column positions for plumbing checks, deck layout, and follow-on trades without returning to the original site benchmark.

70. B — Turnbuckle clevis pins must have their cotter pins installed and spread before the turnbuckle is loaded. Without cotter pins, the clevis pins can back out under load vibration, releasing the guy wire. A released guy removes the lateral restraint from a partially erected column at the moment it is most needed, potentially allowing the column to fall.

71. A — Diagonal distance = $\sqrt{(\text{east}^2 + \text{north}^2)} = \sqrt{(5^2 + 5^2)} = \sqrt{(25 + 25)} = \sqrt{50} = 7.07$ feet. The 5-5-7.07 triangle is a 45-degree right triangle (isosceles right triangle). Option B (7.50) and C (8.00) are too large; D (10.00) would require each leg to be approximately 7.07 feet.

72. B — Each elevation transfer from one benchmark to another introduces a small measurement error. If the floating benchmark carries even a minor error from the original site benchmark, that error is compounded each time the elevation is transferred to the next level. The floating benchmark must be periodically tied back to the original.

73. A — A laser plumb can be set up and leveled quickly without the careful tribrach leveling required for an optical plumb instrument. Many laser plumbs use self-leveling pendulum mechanisms that automatically level within a small range. The optical plumb requires precise tribrach leveling and regular re-checks as temperature changes affect the leveling bubble throughout the working day.

74. B — Non-shrink grout fills the gap between the bottom of the baseplate and the top of the concrete footing created by the leveling nuts used to set the column to grade. Without grout, the column's dead

and live load would be transferred to the footing only through the small leveling nut bearing areas, which are inadequate for long-term loading.

75. D — Total drainage drop = slope per foot x span = (1/8 inch per foot) x 100 feet = 12.5 inches. Option A (8.0 inches) uses a 1/12.5 slope; B (9.5) uses 0.095 per foot; C (10.0) uses 0.10 per foot. The 1/8-inch-per-foot minimum drainage slope determines the required framing elevation variation, which must be designed into the supporting structure.

76. C — A digital angle finder or magnetic inclinometer placed on the column web provides a direct reading of the web's angular bearing relative to level. By comparing the measured angle to the required web orientation from the drawings, the ironworker determines the amount and direction of rotation needed to align the web with the column line.

77. A — In structural steel detailing conventions, a circle with an X through it centered on the hole represents a high-strength bolt in a standard round hole. This symbol differentiates high-strength bolts from regular machine bolts and identifies them as structural fasteners subject to the project's special inspection requirements for bolt installation and pretensioning verification.

78. C — Erection drawings are the primary field documents for ironworkers. They show the overall framing layout with member positions, column line dimensions, member elevations, and each member's erection mark matching the paint mark on the steel itself. Erection drawings allow ironworkers to identify each piece, confirm its location, and understand connections to adjacent members.

79. B — A column schedule lists each column mark and provides its section designation, material specification, total length, splice locations with distances from the base, and connection details at each beam or bracing framing level. Ironworkers reference column schedules to verify that delivered columns match the structural drawings before placing the column into position during erection.

80. D — In structural bolt notation, SC stands for Slip Critical — a connection type requiring fully pretensioned bolts in a Class A or Class B faying surface connection where friction prevents relative slip between plies under service load. SC connections are required where slip would be structurally unacceptable, such as in seismic and wind-braced frames, moment connections, and column splices.

81. C — Conflicting information between drawings must never be resolved unilaterally in the field. The ironworking crew does not have authority to determine which drawing governs — that decision requires engineering judgment from the engineer of record who designed both systems. Erecting steel in the wrong location may create conflicts with other systems and require expensive corrections.

82. D — The tail of a welding symbol can contain a reference to the applicable WPS, a special instruction, or a code specification. When the tail reads AWS D1.1 PREQUALIFIED, it instructs the welder to use a prequalified joint design, with welding parameters specified in the project's prequalified WPS for that joint geometry and base metal combination.

83. C — The circle at a column line intersection with a label inside identifies the column mark at that grid location. Label A1 indicates the column at the intersection of column line A running one direction and column line 1 running perpendicular. This grid reference matches the erection mark on the steel to a.

84. A — SJI specifications require K-series bar joists to have a minimum bearing of 2-1/2 inches on structural steel, ensuring the joist seat and bearing surface can distribute the end reaction without overstressing the seat or allowing the joist to slide off the support. On concrete and masonry, 4 inches is required.

85. B — DLH-series (Deep Longspan) bar joists span from 89 to 240 feet, making them the longest-spanning bar joist family in the SJI catalog. They are used for large-bay industrial buildings, convention centers, and aircraft hangars where clear spans exceeding 100 feet are required. LH-series spans up to 96 feet; K-series spans up to approximately 60 feet.

86. D — A joist girder carries concentrated loads from bar joists at discrete panel points along its top chord rather than uniformly distributed load. Each bar joist reaction is an applied concentrated force at its connection point. Between panel points the top chord spans as a beam between web members, developing local bending moments.

87. A — End anchors at exterior building walls provide lateral restraint for bar joist ends at the perimeter of the building. OSHA 1926.757 and SJI specifications require that joist ends at exterior walls be anchored to the supporting structure to prevent the joist from being dislodged laterally by wind uplift or horizontal forces.

88. C — A bridging terminus point is a structural element capable of absorbing and transferring the cumulative lateral force from all bridging lines connecting to it. Typical terminus elements include masonry walls, concrete shear walls, or structural columns connected to the building's lateral system. SJI specifications require bridging to terminate at a structural element.

89. A — A DTI washer has small protrusions that are compressed as the bolt is tightened. At minimum required pretension, approximately 50 percent of the protrusions should be compressed enough that a feeler gauge of the specified thickness cannot be inserted between the DTI and the adjacent nut or bolt head at those locations.

90. C — A490 bolts are used when the structural connection design requires higher bolt tension or shear capacity than A325 can provide at the available diameter. The engineer specifies A490 when computed demand exceeds A325's capacity. A490's higher pretension provides greater slip resistance at the same bolt diameter when used in fully pretensioned slip-critical connection designs.

91. C — The pre-installation verification test (PIVT) uses a Skidmore-Wilhelm calibrator or equivalent to verify that the specific fastener assembly from the delivered lot produces the required pretension on the actual job site using the contractor's equipment and method. Thread condition, lubrication, and nut fit in a given fastener lot affect the torque-to-tension relationship.

92. B — AISC Specification J3.2 requires hardened washers under both the bolt head and the nut when either element bears over a short-slotted hole parallel to the load direction. The slot weakens the bearing area under the bolt head or nut, creating a risk of the fastener pulling through the slot under tensile load.

93. B — The ironworker's spud wrench (alignment bar) has two primary functions: the tapered tip is driven into misaligned bolt holes to bring them into alignment, allowing bolts to be inserted; and the

box-end wrench head tightens connection bolts to snug-tight during erection. The combination of alignment tip and wrench end makes the spud.

94. C — Electric impact wrenches can include programmable electronic torque shutoff that stops the wrench at a preset torque level, making them suitable for applications requiring repeatable torque measurement. Pneumatic wrenches are controlled by air pressure, which is less precise. Electric wrenches are used in quality-controlled bolting programs where repeatability and data logging of tightening results are required by special inspection.

95. A — An annular cutter removes only the thin ring of material at the hole's perimeter, leaving a solid core plug ejected when the hole is complete. A twist drill removes all material across the full hole diameter. For large-diameter bolt holes in thick structural steel this reduces drilling time and tool wear substantially compared to twist drill bits of comparable diameter.

96. D — An oxygen lance generates temperatures of approximately 8,000 degrees F by igniting a steel tube packed with iron rods and flowing high-pressure oxygen through it. At this temperature the lance burns through reinforced concrete and masonry that stop conventional oxyfuel torches. It is used in demolition, rescue, and cutting heavily embedded anchor.

97. A — AWS D1.1 Clause 7.7 limits through-deck stud welding to studs with a maximum 3/4-inch shank diameter. Larger studs require more arc energy and longer arc duration than through-deck welding can reliably sustain while simultaneously burning through deck material and achieving full fusion at the beam flange. Larger studs require more arc energy.

98. D — At the diaphragm boundary, lateral forces collected by the floor or roof deck must be transferred to the boundary members (beams, drag struts, collectors) that deliver them to the building's vertical lateral force-resisting system. This transfer is accomplished through the fasteners connecting the deck to the boundary beam, which must carry the full accumulated in-plane shear from the deck.

99. C — The SDI Diaphragm Design Manual calculates the in-plane shear demand at each location in the deck based on the building's lateral load and the deck's tributary area. Perimeter and edge zones carry the highest accumulated shear because all forces from the interior deck must pass through them to reach the lateral resisting system.

100. B — When deck ribs run perpendicular to composite beams, the deck sheets end over the beam flange and must lap there to provide continuous bearing. Both the upper and lower sheets must be fastened through to the steel beam at this end-lap location to ensure the lap connection has adequate support beneath it.