PE

3 PDH

STRUCTURAL STEEL / FABRICATION / FIELD INSPECTION

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Structural Steel Fabrication, Shop Drawings & Field Inspection

An engineering workflow from approved design requirements to traceable fabrication and field acceptance

3 Professional Development Hours | Self-paced engineering education | November 2026 edition

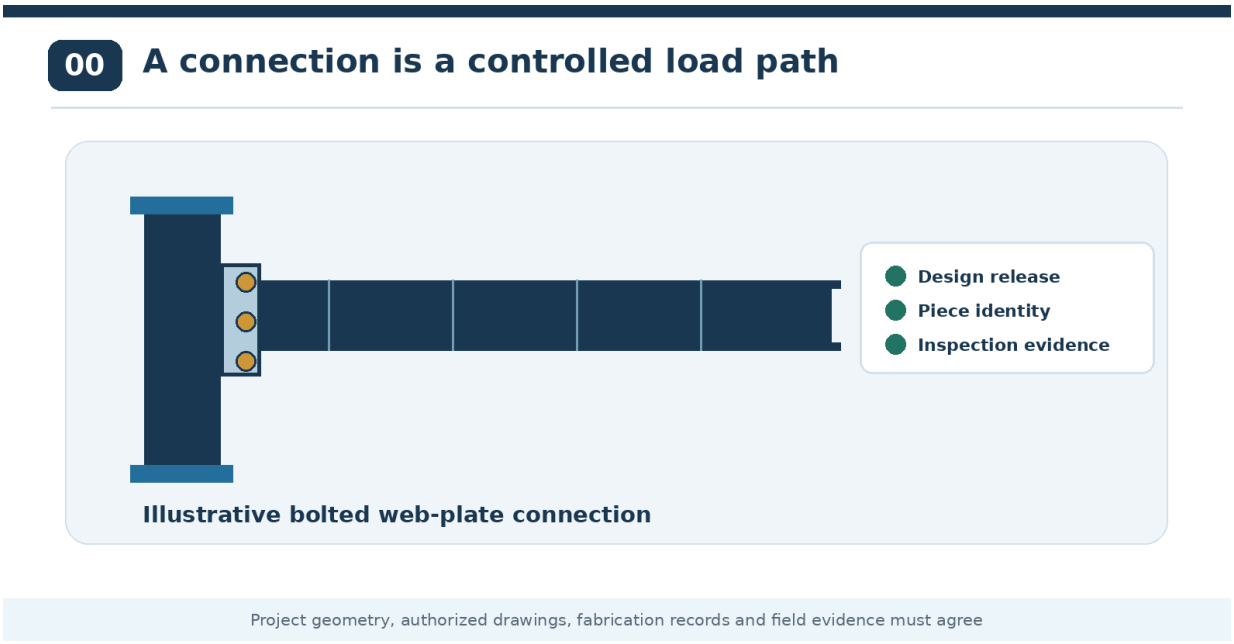


Figure Cover. Original conceptual illustration of a steel beam-web connection and its verification records.

Structural steel construction succeeds when the physical piece, the controlled drawing, and the inspected connection all describe the same engineered intent. A clear detail can prevent rework; an incomplete submittal can hide a load-path change; and a field inspection is useful only when it is tied to the governing acceptance criteria. This course follows a fictional steel-frame project through drawing coordination, shop production, bolting, welding, erection, inspection, and closure of an unexpected field condition.

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How to use this course

This is a practice-oriented engineering continuing-education course. Work through all three modules, study the original schematics, use the controlled-record exercises to make decisions, and compare your reasoning to the stated decision principles. The illustrations are conceptual and not construction-ready details. Every fictional dimension, member mark, and project record is an instructional example; never use it as a design without a project-specific engineering check.

The governing documents are the applicable adopted building code, contract documents, approved design criteria, and editions explicitly identified for the project. Published standards evolve. This November 2026 edition draws on AISC 360-22 and 303-22, including published 2026 errata; the 2025 RCSC specification; AWS D1.1/D1.1M:2025 with Amendment 1; and AISC 207-25 for certification-program context. Adoption dates and contract obligations are not interchangeable with publication dates. Where a project incorporates an earlier edition, use the adopted/project-mandated text and any applicable authorized revisions rather than silently substituting a newer one.

Learning outcomes

1. Distinguish design intent, delegated engineering, detailing, fabrication, erection, and inspection responsibilities without treating a shop-drawing stamp as blanket authorization for changes.

2. Read a controlled steel submittal for geometry, piece marks, material identification, load-path assumptions, connection categories, weld symbols, fabrication notes, tolerances, and revision status.

3. Describe material traceability and the sequence of cutting, fit-up, welding, dimensional checks, surface preparation, shipping, and preservation of objective records.

4. Differentiate snug-tightened, pretensioned, and slip-critical joint requirements and identify when preinstallation verification and installation observations are necessary.

5. Select appropriate preweld, in-process, postweld, and field inspection checkpoints while distinguishing quality control, quality assurance, and acceptance authority.

6. Recognize erection-stage instability, fit-up discrepancies, damaged material, and unauthorized changes requiring a hold, RFI, nonconformance record, or engineering disposition.

7. Assemble a practical field inspection and closeout record that identifies requirements, observations, responsible parties, dispositions, and the evidence needed for acceptance.

Instructional time allocation

Module 1: Documents, responsibilities and shop drawing control | 60 minutes (30 reading/diagrams, 25 application, 5 consolidation).

Module 2: Fabrication, welding, bolting and quality records | 65 minutes (35 reading/diagrams, 25 application, 5 consolidation).

Module 3: Erection interfaces, field inspection and closeout | 55 minutes (30 reading/diagrams, 20 application, 5 consolidation).

Total: 180 minutes of structured instruction and applied exercises. The assessment is administered separately from this learner text. A learner must work the activities rather than relying on page count as a proxy for the allocated time.

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Navigate this manual

Module 1 | Documents, responsibilities and shop drawing control
Module 2 | Fabrication, welding, bolting and quality records
Module 3 | Erection interfaces, field inspection and closeout
Applied engineering worksheets
Glossary and authoritative technical sources

Field release gates at a glance

Stage	Verify before release	Escalate when
Shop detail	Current design, marks, dimensions, connection basis	An unapproved deviation or unresolved RFI exists
Shop fabrication	Material identity, WPS, process controls, inspection log	Traceability or process evidence is missing
Field installation	Erection status, assembly category, access, hold points	Stage stability or connection requirements are uncertain
Closeout	Disposition, retesting, survey, final record revision	A finding lacks authorized final acceptance

At every gate, a physically plausible connection still requires the appropriate authorization and objective evidence.

MODULE 1 | Documents, responsibilities and shop drawing control

60 minutes | Reading and diagram analysis 30 min | Applied worksheet 25 min | Consolidation 5 min

A shop drawing is a manufacturing instruction derived from the contract; it is not an alternative design specification.

1.1 Establish the controlling design and the division of responsibility

Begin with the issued-for-construction structural documents, design loads and applicable specifications. Identify the structural engineer of record, the owner-designated representative for design, the contractor, detailer, fabricator, erector, connection designer where delegated, and the party authorized to issue contract changes. The labels and exact authority vary with the procurement and AISC 303-22 definitions. A responsible engineer cannot infer authority solely from who sends an email or whose software contains a model. A documented responsibility matrix is especially valuable when steel fabrication and erection are contracted separately.

The design documents should communicate the structure's performance requirements and the information necessary to develop connection details. When connection design is delegated, clearly identify the applicable forces, stiffness or deformation assumptions, load combinations, seismic requirements where relevant, and responsibility for sealed calculations. The engineer responsible for the primary structural system must still evaluate how connection details affect that system, consistent with the allocation in the contract and AISC 303. A fabricator's detailer transcribing the specified connection is not automatically authorized to redesign the lateral-force-resisting system.

A common failure is treating an approval stamp as retroactive permission for a new load path. For instance, replacing a moment connection with a shear connection because it is easier to fabricate may release end rotation and alter frame stability. A shop drawing cannot authorize that substitution merely by showing it clearly. Document the proposed deviation, route its engineering effects to the appropriately authorized designer, and obtain the contract approval before fabrication release. Conversely, a minor drafting correction that restores conformance should not be inflated into a complete redesign. The objective is to match decision authority to the significance of the change.

1.2 Build a controlled information chain

Control begins at a baseline register of drawings, specifications, approved RFIs, sketches, submittals, revisions, and documented deviations. Record the drawing number, revision, date, discipline, reference status, approval outcome, and distribution. A good revision log answers two questions at any fabrication station: what is the current governing instruction for this piece, and what physical work may have been performed under an earlier one? The second question is as important as the first when a field change arrives after a shop cut list has been released.

Distinguish three information states. A requirement is enforceable because it appears in the governing documents or in an authorized change. An assumption is a working condition that still needs verification. An open discrepancy is incompatible information that must be resolved. On a composite

steel frame, an architectural soffit elevation, a structural top-of-steel elevation and a mechanical penetration requirement can all look individually plausible while being mutually inconsistent. An RFI should show the precise conflict and request a decision without proposing an unexamined structural concession.

Issue-controlled release generally proceeds from design documents through detail preparation, review, resolution of comments, and documented release for fabrication. There may be different release statuses for fabrication, procurement and erection. Each status should have an explicit meaning. "Reviewed" is not a substitute for "released" unless the contract makes those states equivalent. Fabricator quality personnel should verify that work orders, CNC files, templates and travelers all point to the released revision. A PDF in the project mailbox is not proof that the cutting machine received the update.

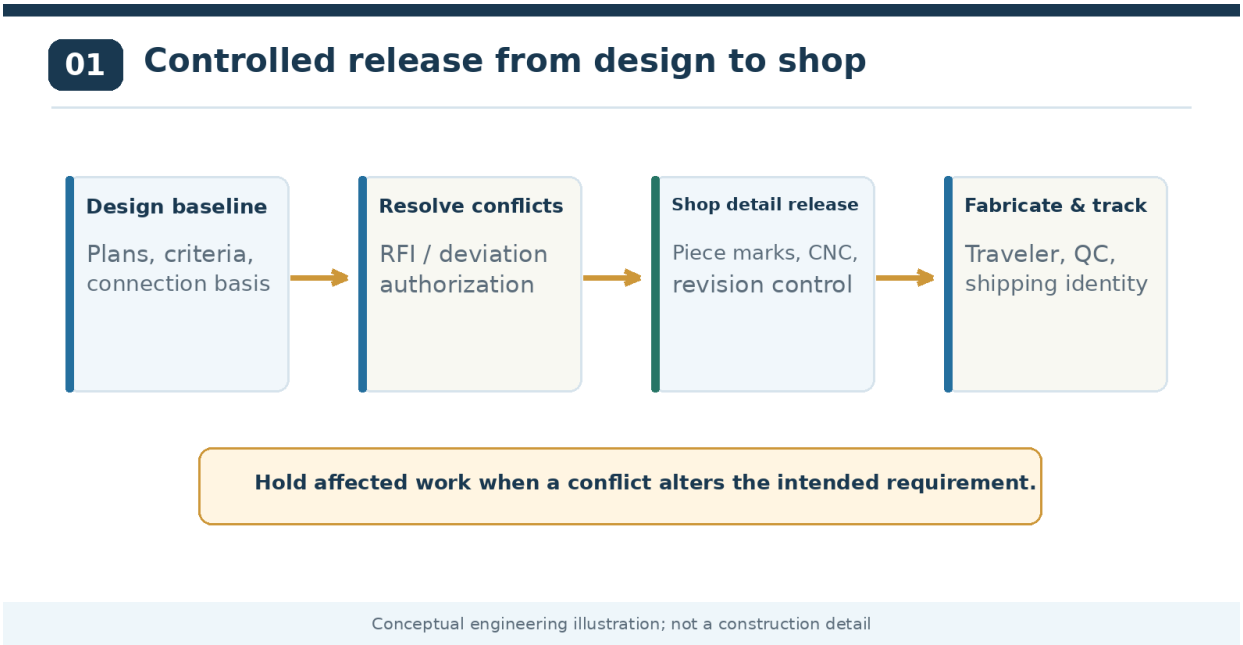


Figure 1. Changes must be resolved and distributed to the shop, not merely marked on one drawing.

1.3 Audit a shop drawing before examining weld or bolt size

Work from global geometry toward local features. Confirm grid lines, column and beam marks, orientation, work points, elevations, camber when specified, field splices, member material and connection locations. Trace a typical piece from the erection plan to its shop detail and material list. Check that marks are unique where needed, that mirrored assemblies are not inadvertently interchangeable, and that field dimensions are marked for verification rather than silently taken from an idealized model. In existing buildings, surveyed as-built geometry may take precedence over nominal drawings for fit-up, but it cannot override an engineering requirement without authorization.

Then inspect member dimensions, hole locations, gage and edge distances, plate thicknesses, weld type and size, access for welding and bolting, shop-versus-field designation, coatings, and finish requirements. A dimension chain that closes numerically may still be wrong if it uses a different work point from the erection plan. Elevations that look close should not be rounded until tolerance requirements have been checked. Review units explicitly, particularly when supplier data, survey

models and shop software use mixed unit conventions. Recheck a changed column splice elevation against stairs, cladding, decking, fireproofing and access requirements.

For bolted connections, verify the specified bolt assembly, hole type, installation category and faying surface requirements where relevant. For welded connections, confirm weld symbol interpretation, joint configuration, backing or access-hole requirements, inspection access and whether the joint requires qualification or special inspection. The field detail must be physically inspectable. A weld hidden behind a closure plate after installation may be impossible to inspect by the specified method, even if the connection is structurally adequate on paper. Coordinate sequencing and access before procurement makes the geometry irreversible.

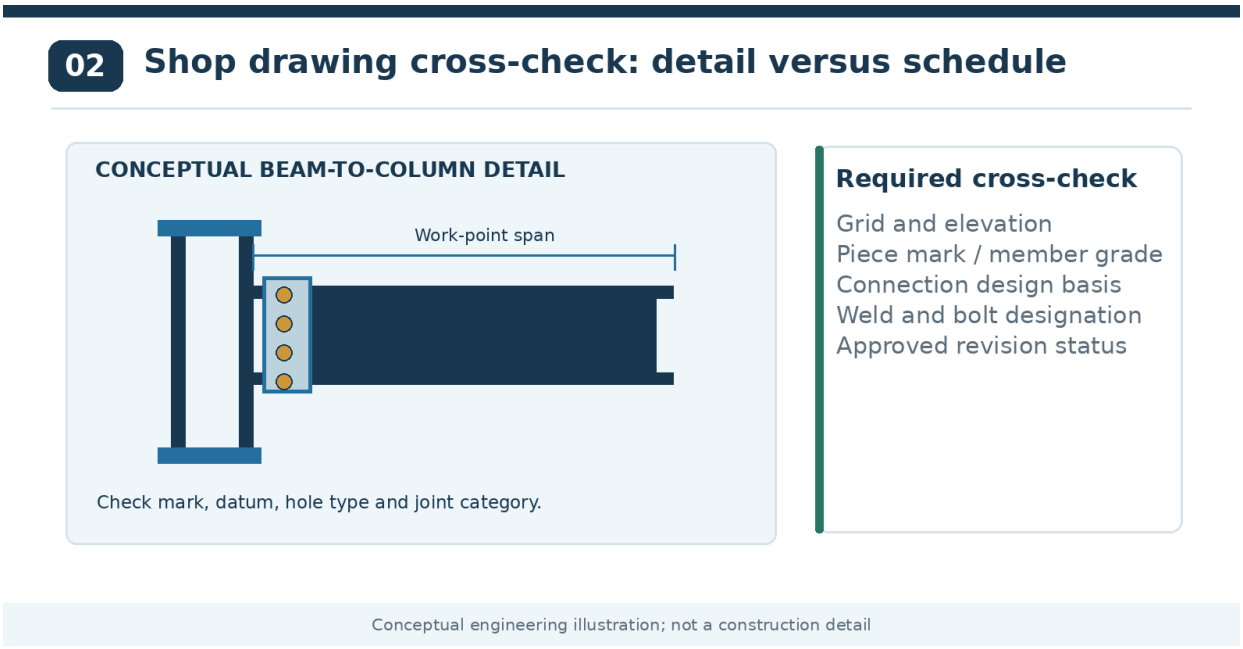


Figure 2. Independently check piece identity, controlling geometry, connection requirements and revision status.

1.4 Read connection behavior, not simply symbols

Typical simple-shear connections transfer transverse force while allowing the beam end rotation assumed by the framing model; actual connection restraint depends on detail and loading. Moment connections transfer moment and associated force components. Bracing gussets can transfer axial forces whose in-plane and out-of-plane effects interact with beam and column behavior. The fabrication detail needs to reflect the intended action, member orientation, load direction and compatible deformation. A dimensioned plate is not sufficient evidence of strength, ductility or seismic qualification.

Consider a shear tab welded to a column and bolted to a beam web. A drawing reviewer checks plate location, number and pattern of bolts, hole types, beam coping, access, plate-to-column weld, adjacent column elements and the approved connection basis. The reviewer should ask who designed that connection and whether the documented design loads match the current framing analysis. Adding a row of bolts is not always a harmless improvement: a longer connection can affect rotational stiffness, eccentricity, fit-up and beam-end geometry. A field crew must not enlarge holes or remove an interfering bolt to achieve alignment without an authorized resolution.

In a moment frame, continuity plates, doubler plates, weld access holes, protected zones and required inspection can be essential. The applicable seismic provisions, contract documents and qualified design are controlling; a generic schematic does not establish those requirements. Never assume that using an apparently stronger weld is always acceptable, because increased restraint, heat input or a changed fatigue-sensitive detail can cause a different failure mode. Inspect the engineered assembly as a system rather than approving individual symbols in isolation.

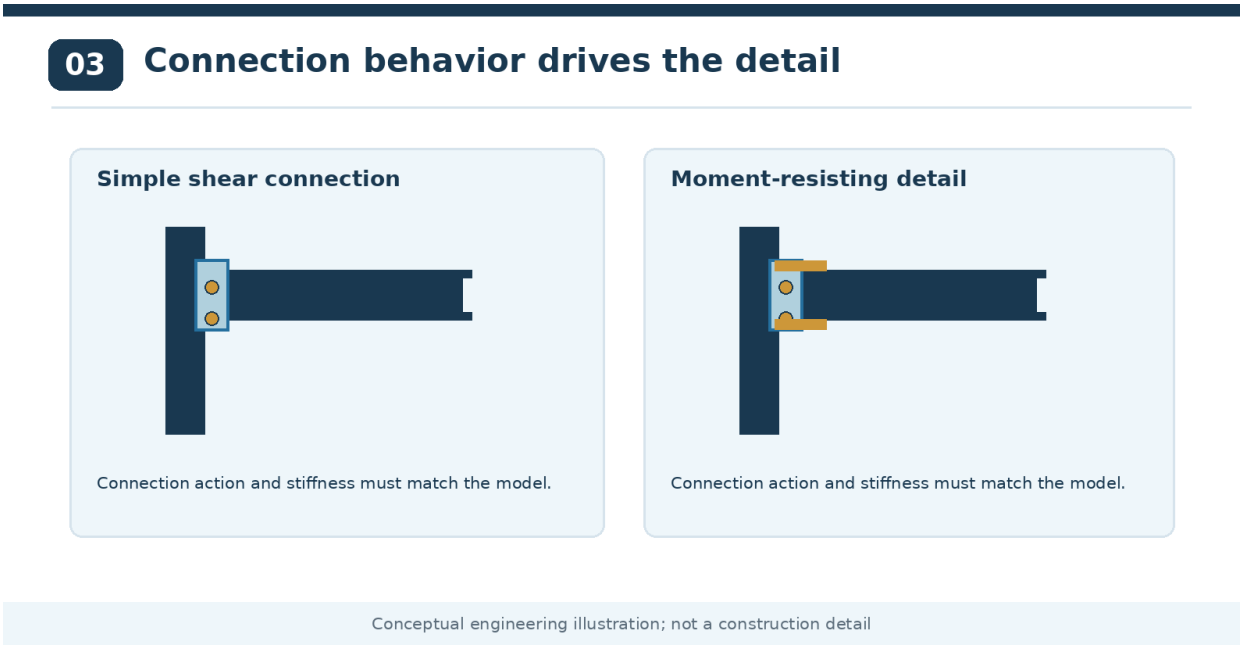


Figure 3. Shear and moment connection schematics are illustrative; final adequacy depends on the engineered design.

1.5 Understand fabrication and erection deliverables as distinct records

Shop fabrication drawings instruct the shop on piece-level cutting, holes, welds, fit-up, marks and finish. Erection drawings place marked pieces into a structural frame and show layout, location, field connections, and sequence-related information where assigned. Connection calculations and delegated-design submittals are a separate engineering deliverable when required. Material purchase orders and bills of material support purchasing and traceability but are not a substitute for the approved member detail. A digital model can support coordination but does not itself establish contractual authority unless the agreement explicitly provides for that workflow.

The submittal package should be complete enough for a coordinated review. If all column marks are present but the related bracing details are omitted, the engineer may be unable to assess frame stability or load transfer. If a revised end-plate detail changes bolt access, update the erection sequence and inspector access assumptions as well. A useful completeness check compares three indexes: design grid/framing index, fabrication piece-mark list, and erection connection schedule. Missing or duplicated marks should be flagged before a load of steel arrives at the site.

For architecturally exposed structural steel, appearance criteria, tolerances, weld finishing and coating/finish sequencing may be more demanding or differently defined than for concealed framing. Do not extend an appearance requirement to an unstated structural acceptance criterion. Clear drawings and contract documents should distinguish the two; both can affect cost and shop approach.

A shop detail that does not state a required finish cannot be repaired at the end through an informal instruction that changes labor, materials and surface condition without documenting the change.

1.6 Worked case: the offset connection that looked plausible

A fictional seven-story building uses nominal W-shape floor beams. Grid C/5 includes an angled facade bracket; an architectural change shifts the bracket centerline 2 in. The current shop sheet still shows the previous centerline and proposes a new row of holes to recover clearance. The fabricator reports that the revised layout can be cut this afternoon. The erection plan has not changed, and the connection calculation references the prior eccentricity. The red flag is not the number of inches alone; it is the combination of changed eccentricity, an unreviewed hole pattern and mismatch across coordinated documents.

The appropriate initial action is to place affected work on hold, preserve the prechange material status, and issue a targeted RFI identifying drawing numbers and revisions. The designated connection engineer evaluates the altered geometry and loads. The engineer responsible for the primary system determines whether the change affects the supported frame, and the authorized project representative documents disposition. Once approved, the detailer revises the detail, bill of material, CNC instructions, erection connection list and inspection plan. Only those marks whose released details have changed should be reworked, but their identification must be unambiguous.

A poor response would be to drill both patterns and rely on a field inspector to decide which holes to use. Added openings may affect net section, edge distances, slip resistance, appearance, corrosion protection or local member capacity. Another poor response is to release the cut list with a verbal note because the installer can "make it work." A responsible release record states precisely what is accepted, who has engineering authority, which drawings govern, and what reinspection is required.

1.7 Develop a review disposition that can be acted upon

Comments should be specific enough to close. "Check bolts" is not an actionable disposition. "At sheet S-401 Rev 3, detail 12, show the hole type and installation category required by connection schedule C-12; coordinate with the approved connection design" gives the detailer a bounded action. Distinguish an editorial mark, a missing reference, a conflict needing an RFI, and a proposed design change. The disposition log should carry priority, assigned owner, deadline, revised submittal reference and closeout evidence. Critical conflicts must remain visible through approval and fabrication release.

A concise shop-review checklist uses three gates: design consistency, manufacturability and inspectability. The first protects the modeled structural performance; the second prevents avoidable piece or sequence failures; the third ensures the specified acceptance evidence can actually be obtained. Manufacturing improvements are welcome when they preserve design intent, contract requirements and authorized engineering. The best detail is not necessarily the most elaborate detail. It is one that correctly expresses the required behavior and can be constructed, checked and documented.

Module 1 | Applied engineering workshop

Spend 25 minutes using Worksheet A. Compare fictional drawing S-401 Rev 3 with shop sheet B-118 Rev 2: the beam is W18x35 on both, but the piece mark changes B21 to B12; the web-plate gage is

shown as 3 in on one and 3 1/4 in on the other; the contract calls for pretensioned bolts at braced-frame joints; a brace-gusset note on B-118 states snug-tightened bolts; and the detailer has added a field weld to avoid shop handling. Identify each discrepancy, classify it as clerical or potentially structural, identify the authority needed to resolve it, and state whether fabrication can be released. A complete answer must reconcile the revised erection plan, connection basis and bolt installation requirement rather than relying on a visual stamp.

Five-minute consolidation

Before leaving this module, state the difference between a shop detail and an authorized design change. Name the three records you would inspect before allowing a revised piece mark into fabrication: current design/submittal revision, engineering disposition of any deviations, and the updated fabrication/erection release record. Refer to Technical Sources [1], [2] and [3].

MODULE 2 | Fabrication, welding, bolting and quality records

65 minutes | Reading and diagram analysis 35 min | Applied worksheet 25 min | Consolidation 5 min

Quality is the traceable relationship between specified work, controlled production, observed evidence and authorized disposition.

2.1 Preserve material identity from receipt to the final piece

Fabrication starts before cutting. The fabricator receives mill test reports or other required certifications, shipping information, grade identification and dimensions. Receiving personnel match delivered material to purchase orders, specified standards and the controlled fabrication schedule. Record heat or lot traceability as required by the quality plan and project specification; do not imply that every project uses an identical traceability method. A steel piece that appears dimensionally correct can still be incorrect if its material grade or required toughness differs from the project specification.

Material identification must survive cutting, nesting, assembly and shipment. A plate cut from a certified parent plate can lose its provenance when the original heat mark is removed. A documented transfer of markings and production records preserves the traceable chain. Establish the policy for offcuts, substitutions and unidentified stock before mixing them into inventory. Where supplementary impact or fracture-critical requirements apply, traceability and inspection may demand further controls beyond ordinary building steel practice. These are project-specific requirements, not optional labels that can be inferred from appearance.

The bill of material connects design and stock; the piece mark connects stock and assembly; the traveler connects assembly and performed operations. Inspectors need an unbroken path among these records and the physically tagged member. In the field, a member arriving with a correct shape but wrong mark should not be accepted merely because it appears to fit. Compare shipping list, current erection drawings, member stamp, dimensional requirements and material record. Identify the status of work already performed if a discrepancy surfaces after installation.

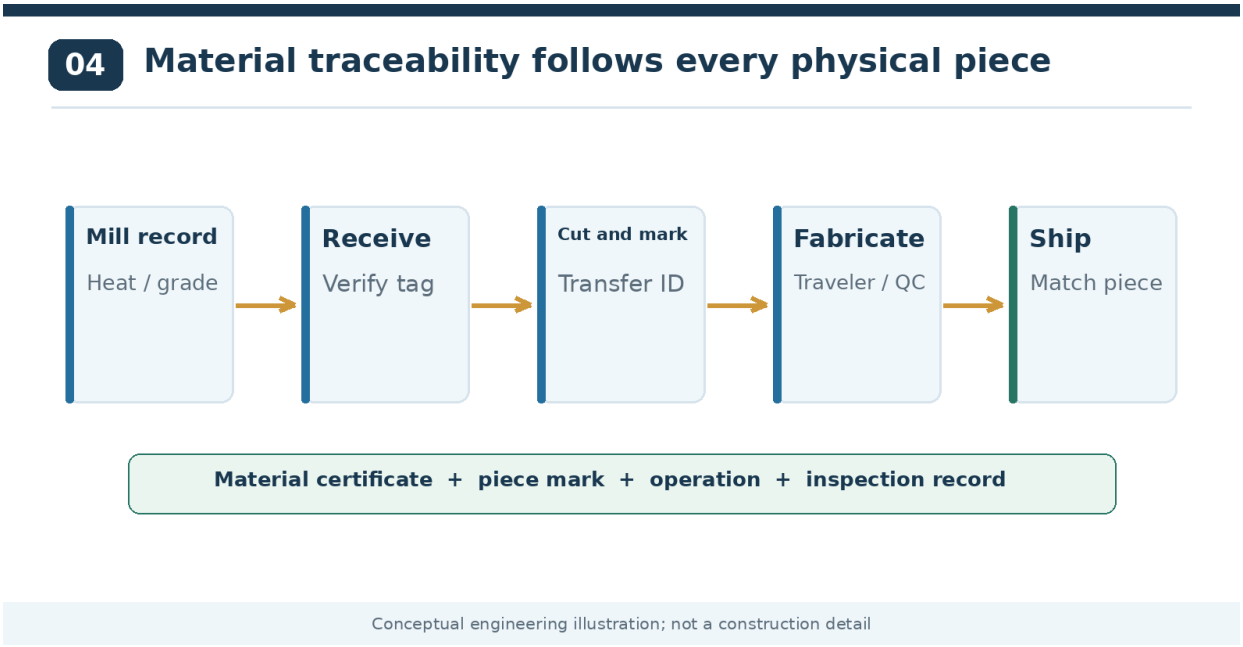


Figure 4. Piece identification links original material certifications to cutting, production and shipment records.

2.2 Fabrication sequencing changes fit and residual effects

Cutting, coping, drilling or punching, fit-up, welding, straightening and coating form a production sequence. Process capability and allowable tolerances determine whether an operation can be performed accurately after another. For example, welding a thick stiffener before checking assembly geometry may create distortion that complicates bolt-hole alignment. A fabrication plan may therefore sequence tack welding, verified fixturing, balanced welding and intermediate dimensional checks to reduce rework. The plan must still satisfy the applicable workmanship requirements and qualified welding procedures.

Check equipment calibration and status where required: measuring tools, hole-making equipment, welding equipment, torque or tension verification devices and inspection instruments. A claimed measurement is only useful if the device, method and inspection condition are appropriate. A documented 0.08-in flange offset cannot be interpreted against a 0.06-in acceptance criterion if the instrument has an unsuitable uncertainty or if the datum was taken from the wrong reference. Do not select a tolerance by habit. Use the controlling AISC 303 provisions, approved specifications and drawings; special geometries or architecturally exposed steel may require additional or different criteria.

Surface condition also affects process success. Remove substances that prevent proper welding or coating when required by the applicable procedure. Guard against weld contamination, excessive heat input, uncontrolled thermal straightening and unqualified repairs. Galvanizing or paint can affect subsequent connection preparation and inspection access. For bolts relying on slip resistance, the condition and classification of faying surfaces are part of the engineered joint and must conform to the specified procedure. A coating substitution or shop touch-up is not necessarily a cosmetic-only change.

2.3 Welding requirements begin before the arc

The Welding Procedure Specification (WPS) defines the permitted welding process and essential variables for the work. Depending on the applicable AWS D1.1 provisions, a WPS may meet prequalification requirements or require procedure qualification supported by a Procedure Qualification Record (PQR). Welder or welding-operator performance qualification is distinct from WPS qualification, and continuity and process applicability must be checked. The relevant D1.1 edition, project specifications, material, process, joint details and positions control. A photograph of a completed weld or an employee's general certification is not sufficient proof that the specific work was performed under a compliant procedure.

Before welding, verify identity and condition of base materials, consumable classification and storage when required, joint preparation, fit-up, access holes, backing, preheat/interpass provisions and the availability of the WPS. The preweld inspection record should identify the joint and the condition that existed before welding made the root inaccessible. During welding, monitor the required process controls, sequence, adherence to WPS variables and any hold/witness points. After welding, perform specified visual examination and nondestructive examination by qualified personnel using applicable procedures and acceptance criteria. The need, extent and timing of UT, MT, PT or other NDT are not universal; they come from the governing provisions and inspection plan.

The distinction between defect, discontinuity and rejectable condition matters. A discontinuity is an interruption in material continuity; whether it is unacceptable depends on the applicable code, location, geometry and criteria. An inspector should record the actual indication and the controlling criterion, not simply mark all visible indications "bad weld." Where an acceptance decision depends on weld size, length, profile, undercut or discontinuity limits, use the appropriate table and measurement procedure in the incorporated edition. The course intentionally does not reproduce proprietary acceptance tables or substitute generic numeric thresholds for the governing text.

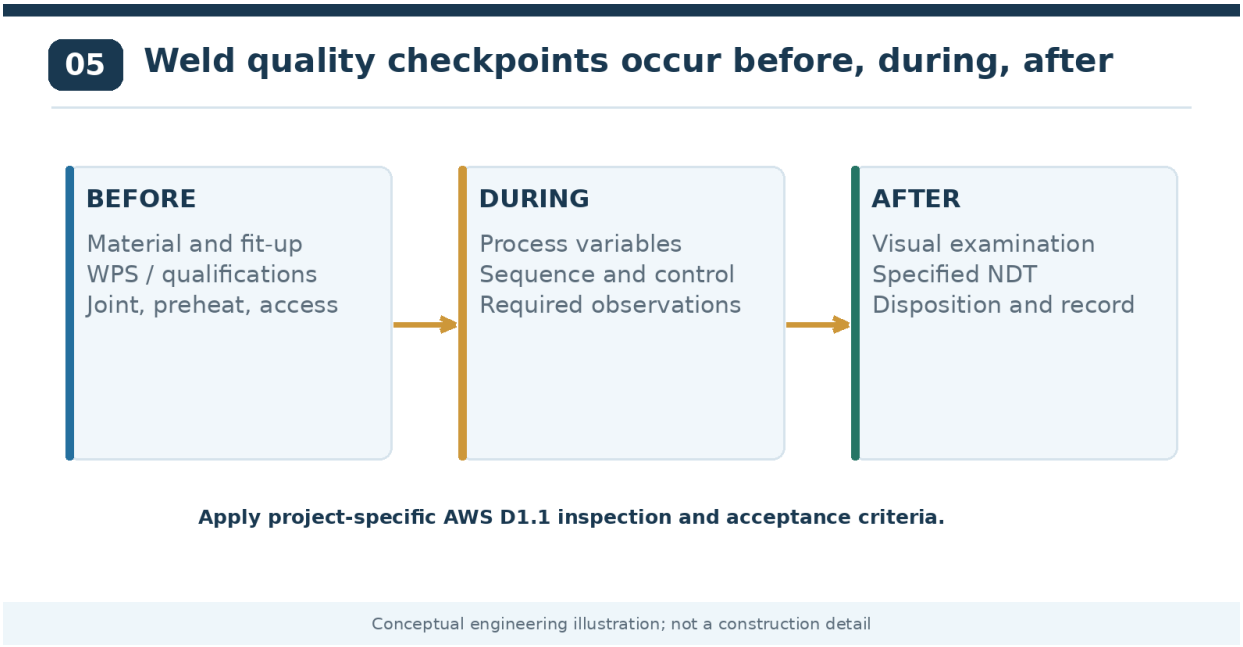


Figure 5. Welding inspections are staged; postweld visual appearance cannot recreate missing preweld evidence.

2.4 Interpret weld symbols as instructions that must be buildable

The reference line, arrow, weld symbol and supplementary indications locate and describe specified welds. Confirm which side of the joint is designated and whether field welding, all-around requirements, effective length, contour or finishing is required. A symbol that is geometrically legible can still be unbuildable if access is obstructed after assembly. Do not confuse a continuous-looking line in an elevation with a continuous weld; interpret the approved weld notation and details. If a required weld cannot be made or inspected in the actual sequence, resolve access and sequence before work proceeds.

For a hypothetical stiffener plate at a beam web, the detail calls for two fillet welds and a specified weld termination adjacent to a flange-to-web region. A shop operator proposes extending the weld because extra metal seems stronger. That may change local restraint, cause a fatigue concern in a repeated-load detail, or violate a weld termination requirement. The approved design and fabrication code govern. Similarly, grinding a weld flush to improve appearance may alter the effective throat or hide damage if done without a compliant procedure. Changes require technical evaluation, not an aesthetic preference masquerading as engineering acceptance.

Where welding follows field fit-up, record the actual conditions: base material and grade, surface condition, gaps, alignment, weather protection, access, WPS and welder qualification. If preheat or interpass temperature control is required, the team must confirm the temperature with an appropriate method at the applicable location and time. A morning reading does not automatically remain valid after the joint cools or conditions change. If the joint is outside the approved fit-up tolerance, do not conceal the gap with added weld metal and then ask the inspector to accept the visible surface. Document and resolve the geometric problem first.

2.5 Bolted connections: design requirement is not the tightening tool

Classify the structural joint using the approved design and governing RCSC specification. Snug-tightened joints rely on the appropriate installation to bring connected plies into firm contact; pretensioned joints require a specified minimum pretension; slip-critical joints rely on an approved faying-surface condition and pretension to satisfy a slip-resistance design requirement. These categories are not interchangeable. A joint described as "high-strength bolts" is not sufficiently specified if the installation and design category affect acceptance. Neither the use of an impact wrench nor an impressive torque number independently proves compliant pretension.

The 2025 RCSC Specification for Structural Joints Using High-Strength Bolts is the latest identified RCSC edition at this course date. It addresses fastener assemblies, holes, installation and inspection. A project may incorporate a different edition through its contract or governing code. Confirm bolt and nut/washer assembly compatibility, required coatings and lubrication, hole type, fit-up, faying surface, installation method and required preinstallation verification. Some installation methods depend on observed rotation, calibrated equipment or a system-specific indication. Acceptable installation evidence is method-specific; a post-installation torque check is not a universal substitute for the required verification and observation.

Preinstallation verification should reflect the actual assembly and method where specified. The installation team and inspector need to know the applicable procedure, equipment, lot/condition

controls, observation responsibility and documentation. If verification fails, diagnose the assembly, procedure, lubrication, equipment or other cause before production installation proceeds. Reused fasteners, mixed lots, changed lubricants and weather exposure can affect behavior; follow the current applicable specification and manufacturer information. A faying surface changed after shop coating may require engineering and quality resolution before slip-critical assembly.

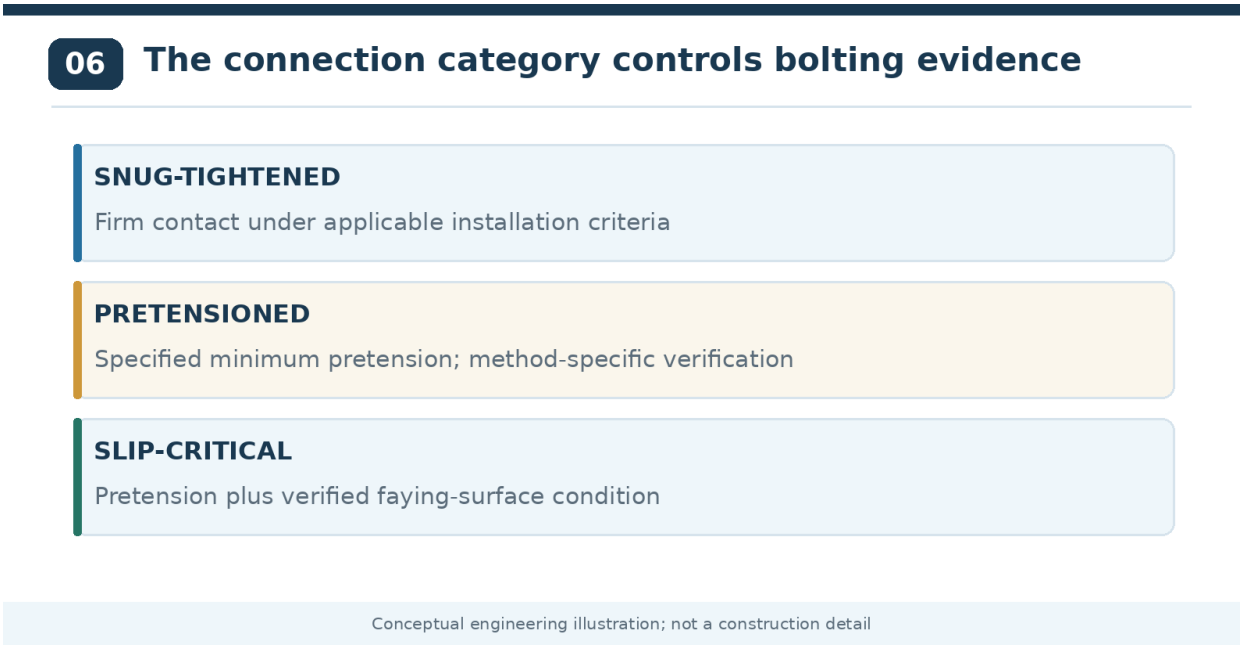


Figure 6. Joint category establishes the necessary design and installation documentation.

2.6 Compare shop QC, project QA and special inspection without blending roles

Quality control is the producer's documented effort to ensure conforming work; quality assurance and special inspection provide separate evidence or oversight according to the specification, applicable building code and contract. AISC 360-22 Chapter N identifies QC and QA inspection framework, with additional project conditions and seismic requirements when applicable. AISC 207-25 describes requirements used in relevant AISC Certification programs; certification is a management-system and capability indicator, not proof that every connection on a particular job has passed inspection. Owners and code officials may require distinct inspectors, certifications or records. Establish the actual inspection scope instead of claiming that one organization can perform every role.

A useful Inspection and Test Plan (ITP) records the work step, governing criterion, responsible party, hold or witness point, method, frequency, required record and release authority. For welding, distinguish preweld checks, in-process monitoring and postweld testing. For bolting, distinguish material receipt, preinstallation verification, installation observations and subsequent checks required by the governing method. For dimensions, distinguish survey and layout before fit-up from acceptance after welding or erection. An inspector witnessing a test is not automatically authorized to approve a design deviation.

Good records identify both conforming work and exceptions. A weld inspection sheet bearing only a generic "passed" stamp may lack location, procedure, criterion, result and inspector identity. Conversely, collecting hundreds of photographs without associating them with a piece mark, weld or

connection makes the evidence difficult to use. Record enough structured metadata to trace the finding to the physical member and design requirement. Preserve records under the project retention plan, including superseded but relevant status and the final corrective-action closure. This is what makes field acceptance defensible during later audits or investigations.

2.7 Nonconforming work needs engineering disposition, not concealment

An NCR should describe the location, controlling requirement, observed nonconformance, immediate containment and status of adjacent work. Containment prevents uncontrolled installation or shipping while preserving evidence. Authorized disposition may include repair, rework to full conformance, replacement, engineering acceptance of a deviation where permitted, or rejection. The responsible engineer must decide structural adequacy when the issue affects design assumptions. Production personnel and inspectors may suggest options, but should not quietly convert a design decision into a shop correction.

For example, suppose a welded connection has an out-of-tolerance fit-up, and a repair subcontractor offers to add a backing plate. The new backing and weld sequence may affect stress, access, toughness, inspection and coating requirements. A compliant correction involves reviewing the approved welding criteria and joint detail, obtaining the authorized engineering direction where needed, using a qualified repair procedure, performing required examinations and logging the closeout. Merely producing a visually smooth repaired surface does not establish that the original defect was removed or that the connection now meets acceptance criteria.

When an NCR is closed, update the as-built/record documentation and any impacted material or inspection log. Reinspection should reference the original finding and repair authorization. The closure packet should be reconstructable by a different engineer who was not present during the issue. Repeat nonconformances may indicate a systemic production-control problem—incorrect templates, poor drawing control, missing fit-up hold points or inadequate training—rather than isolated worker error. Use trend information for prevention without diluting the requirement for individual disposition.

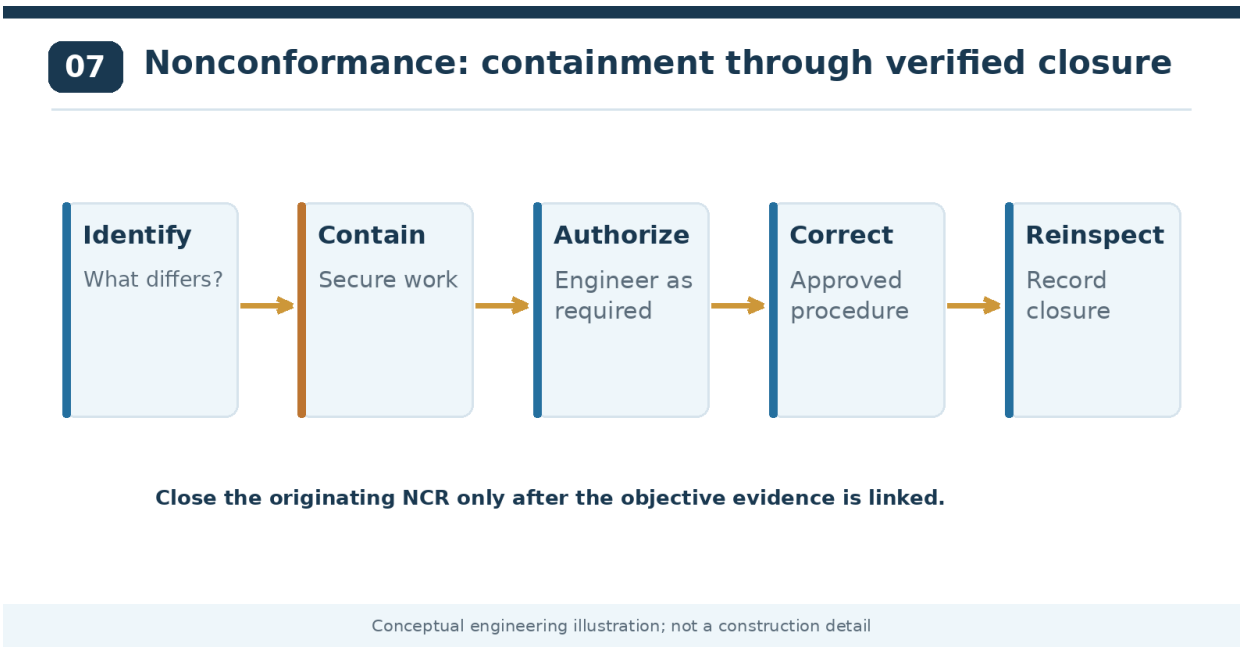


Figure 7. A disposition remains open until the authorized correction and follow-up inspection are documented.

2.8 Worked case: good bolt count, wrong joint category

A fictional lateral-bracing connection has six high-strength bolts. The design schedule identifies it as slip-critical. In the shop, a coating substitution was made at the interface to meet a shortened schedule. The contractor's field plan states "snug-tight installation" because the bolts are accessible and the erector uses an impact wrench. Visual counts, member marks and bolt diameters all match the drawing. None of these facts establishes that the slip-critical design has been met. The engineered faying-surface requirements and pretensioning procedure remain controlling.

Place affected installation on hold and protect the joint from further uncontrolled work. Confirm the governing design category, faying-surface classification and approved coatings; determine whether the selected fastener assemblies and installation method meet the applicable specification. If not, identify a documented corrective route: surface rework and compliant installation, or an engineer-authorized connection redesign with all necessary contract and inspection revisions. Preinstallation verification and observation records are required as applicable to the selected method. The inspector cannot waive the slip-critical requirement just because the field bolts appear tight.

An acceptable completion record would include the affected connection marks, coating/fastener documentation, the engineering or contract disposition, final installation method and quality evidence. A weak record would only say "bolts retightened"; that statement does not demonstrate compliant slip resistance or correct a nonconforming surface. This scenario illustrates the difference between visually obvious features and the less visible performance requirement that governs acceptance.

Module 2 | Applied engineering workshop

Spend 25 minutes completing Worksheet B. Evaluate three fictional production issues: (A) a certified A572 plate loses its heat-trace tag after nesting; (B) a WPS is unavailable at a field welding station and the welder qualification card lists a different process; (C) an inspector is offered only a torque number for a joint scheduled as pretensioned. For each, identify the governing record, immediate

hold/containment, party who can provide evidence or disposition, and required release document. Explain why the absence of evidence is different from proof of a structural failure, while also explaining why work should not be accepted without the required evidence.

Five-minute consolidation

State how an MTR follows a piece mark into a shipping record. Explain the difference between WPS qualification and welder qualification. Describe why bolt pretension evidence depends on the prescribed installation method. Name a complete NCR chain: identify, contain, authorize, correct, reinspect and close. Refer to Technical Sources [1], [4], [5] and [6].

MODULE 3 | Erection interfaces, field inspection and closeout

55 minutes | Reading and diagram analysis 30 min | Applied worksheet 20 min | Consolidation 5 min

The final frame is not the erection-stage frame: inspect what exists now, not only the condition expected at completion.

3.1 Receiving inspection is an information check and a physical check

At delivery, reconcile the bill of lading, shipping list, piece marks and currently released erection drawings. Confirm quantity, identification, member orientation, protective treatment, stored condition and available receiving records. Look for transport damage, distorted plates, bent members, cracked or damaged welds, damaged coatings, absent connection hardware, missing fabrication/inspection documentation and conditions affecting fit-up. Photograph notable exceptions with a scale and a readable mark reference. Physical resemblance to an intended member does not replace material identity or the current piece-mark system.

Store members on supports that prevent damage and accumulation of water, with stable access and a plan for lifting. Protect bolt assemblies and consumables according to manufacturer and code requirements. If a piece is missing, do not automatically substitute an apparently similar stock member. Confirm its grade, size, connection configuration, required tests and design implications. The field receipt log should separate accepted-for-storage material from accepted-for-installation material; a piece may be inventoried while still on technical hold.

The erection team and inspector need one common revision baseline. A revised column base plate may affect anchor-rod projection, hole fit, grout clearance and survey datum. If the latest erection drawing differs from the current field layout, stop affected work until the issue is resolved. Do not treat a crane pick or concrete pour deadline as evidence that a discrepancy is minor. The most valuable receiving inspection often catches a mismatch before the member is placed where it is difficult to recover.

3.2 Erection stability must be evaluated for intermediate stages

Before steel stands independently, its lateral stability and load path may differ from the final braced or diaphragm-supported building. The erecting contractor must have an engineered means-and-methods plan appropriate to its assigned responsibilities, including temporary supports, bracing, connections, crane loading, sequence, wind and weather limits, and removal conditions. Temporary stability is not implied by final structural drawings. The qualified parties must evaluate lifting points, temporary forces, anchor reactions, excavation/interface hazards and the consequences of releasing a crane while the frame lacks its required restraint.

An isolated beam sitting on seats with a few bolts may not be stable against torsion or lateral displacement under the construction condition. A column may be temporarily held by guying or bracing not shown in the final frame. A partly completed braced bay can have a very different lateral response until all required elements and connections are engaged. Field inspectors can verify whether the specified temporary systems and hold points are being followed and flag deviations, but they

should not invent bracing design in the field. If the erection plan is unavailable or the temporary restraint differs materially from the plan, escalate immediately.

Remove temporary bracing only under the authorized sequence and after evidence shows the permanent load path is sufficiently established. A completed deck placement is not by itself proof that every connection required to stabilize the structure has been accepted. Similarly, a staged concrete slab may not develop composite or diaphragm behavior until conditions specified by design have been met. Recognize that temporary load cases include construction equipment, stored materials, personnel, wind, lifting impacts and other effects governed by the project. Do not use the final-service analysis as a stand-in for erection engineering.

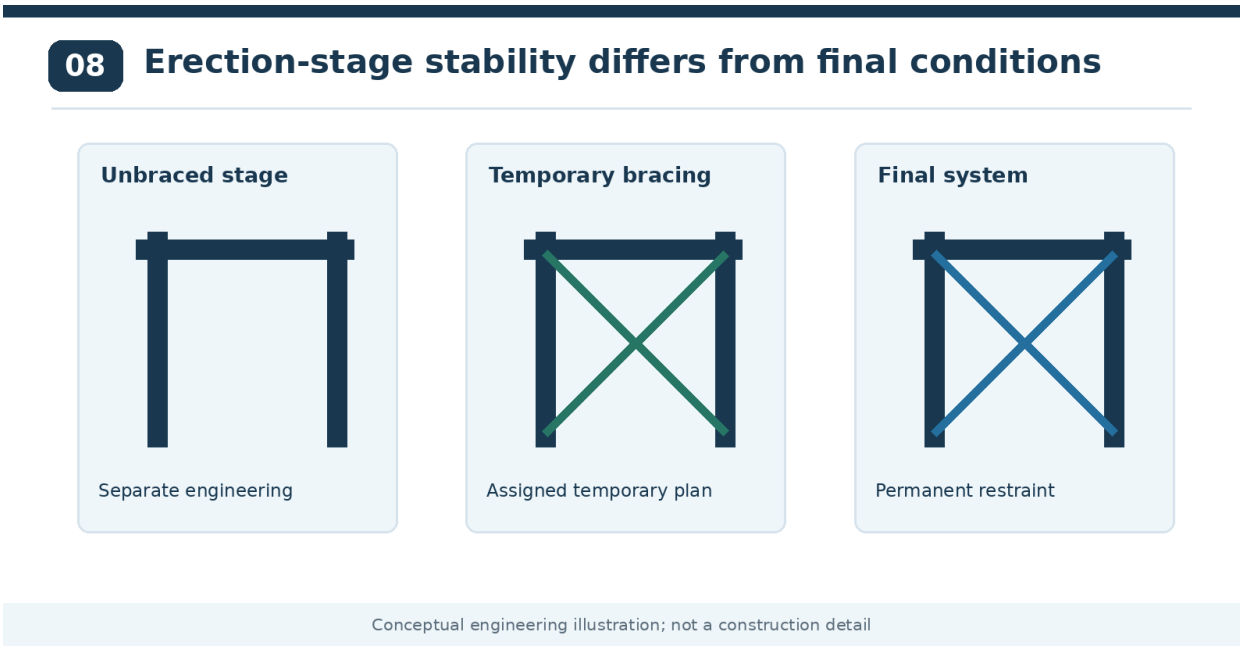


Figure 8. The final lateral system cannot be presumed active during intermediate erection stages.

3.3 Inspect field geometry and connection work in the right sequence

Survey grids, levels and alignment before forcing connections to fit. Verify column plumbness and beam elevations at the stage identified by the applicable erection tolerances. Check base plates, anchor rods, bearing/contact conditions, shim/grout status, splices and connection orientation. Site measurements must use the prescribed datum and appropriate method. A nominally small discrepancy between the foundation survey and erected column grid can propagate through cladding, floors and bracing; the resolution should address the system rather than disguising the problem with accumulated field adjustments.

For bolting, confirm assembly identity, hole and faying-surface condition, joint category, required preinstallation verification, installation procedure and inspection observations. The field record must distinguish what the inspector witnessed from what the crew reported. For welding, check approved WPS and applicable qualifications, joint condition, access, environmental controls and the required inspection stages. Where inspection is required before closure or concealment, treat that as a hold point. Any alteration to a member, weld or hole geometry outside permitted workmanship needs a formal disposition rather than an undocumented "field fit" adjustment.

If steel is out of alignment, first determine whether the source is survey control, fabrication dimensions, erection fit-up, a changed adjacent structure, or temporary loads. Do not resolve a conflict by pulling a member into place if that creates unintended stress or alters the approved connection behavior. The responsible engineer and erection specialist should evaluate the proposed action. Field inspectors can accurately document measurements and observations without claiming that they have recalculated the frame. Distinguishing observation from structural acceptance protects both safety and role clarity.

3.4 Use an inspection plan that follows physical work

A practical field ITP uses clear hold points: before installation (identification and released documents), before irreversible connection closure (fit, surfaces and qualifications), during selected installation operations (required method observations), after connections (postweld/NDT/bolt evidence), and before removal of temporary works or final release (geometry and authorized completion records). Not every project requires identical hold points. Adopt the contractually required inspections and add project-specific ones where the designer and owner determine they are warranted.

For an observed nonconformance, record time, weather if relevant, grid/piece mark, current drawing and detail, actual measured condition, acceptance criterion, photographs or inspection data, immediate isolation, person notified and disposition status. Write "measured hole offset 5/16 in relative to surveyed datum X" rather than "the bolting is bad" if the cause and governing tolerance remain undetermined. An inspection record should make the next decision easier for the authorized party. Inspection reports that repeat generic acceptance words without location or method are poor evidence of compliance.

Closeout is an engineering-data task. It reconciles issued changes, approved substitutions, inspection/test reports, NDT records where required, repair histories, coating repairs, survey results, and as-built or record documents. A complete closeout table names the affected location, governing requirement, final evidence and acceptance authority. Outstanding exceptions should remain open with visible status; silence or shipment does not equal acceptance. Turnover should also retain operation and maintenance constraints for exposed steel, coatings and connections when such documents are within project scope.

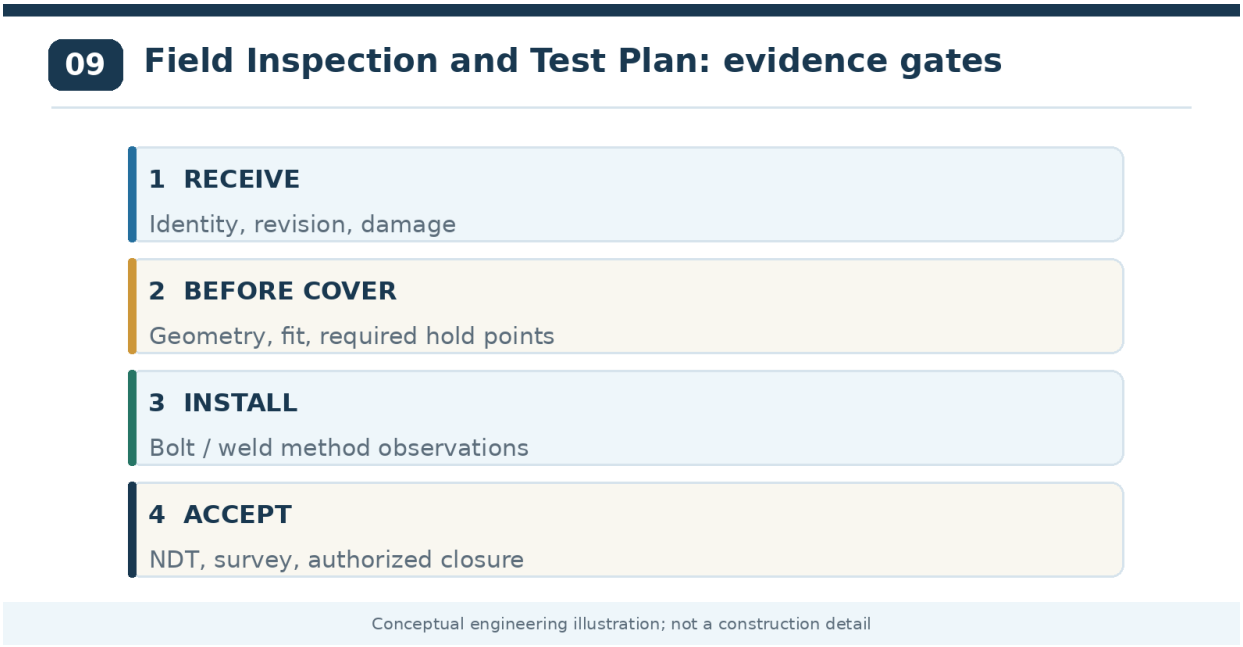


Figure 9. Field inspection gates are sequenced around irreversible work and evidence preservation.

3.5 Worked case: the splice that will not close

At grid B/7, a fictional steel beam splice has a 3/8-in mismatch between bolt patterns after erection. The erector proposes flame-cutting two holes into slots, tightening the bolts and placing a cover plate behind the joint. The approved drawings indicate standard holes and a pretensioned joint. Another nearby beam shows a larger than expected construction deflection because decking is not yet present. The issue may be caused by fabricated hole position, survey control, temporary frame behavior, wrong piece orientation or a prior revision. A slotting proposal affects connection geometry and may affect bearing, tear-out, pretension distribution, and installation/inspection requirements.

Stop modification and hold the affected connection in a safe condition under the erection plan. Document the measured offset, actual hole layout, piece marks, revision and support configuration. Ask the fabricator to verify as-built shop dimensions and the erector to check survey and temporary geometry. Refer the proposed correction to the authorized connection designer and primary system engineer as appropriate. Corrective action could require re-fabrication, engineered rework, a revised connection design or a change in erection sequence; the instructor cannot predetermine that choice from the limited facts. Update the controlled documents and inspection plan before work resumes.

A field inspector's role is to report observations and verify that the authorized correction is executed and inspected. If an engineer accepts a modified connection after checking design adequacy, the acceptance packet should include the engineering direction, revised details, material/fastener requirements, method of work and required inspections. The closeout must show what was built, not just what was originally intended. Unreviewed slotting is not justified by the observation that bolts can physically pass through a larger opening.

3.6 Integrated case: two changes, one shared load path

The fictional Harbor Annex project has three design areas: an ordinary gravity steel bay, a lateral brace bay and a roof mechanical frame. The designer changes a roof equipment pad after the steel

purchase order. The detailer accommodates a new penetration in a beam web, while the erector reports that the braced bay column is 1/4 in out of intended alignment. Both changes appear local. The correct review considers whether the new opening reduces member strength or affects serviceability, whether any stiffening or reinforcement is required, and whether the brace-bay misalignment changes connection fit, member forces or temporary stability. Neither issue should be accepted by visual judgment alone.

A disciplined project team opens two linked issue records. The web opening goes to the primary structural designer for an authorized design response, then to the detailer and fabricator for updated release and inspection requirements. The brace alignment first requires verified survey, current erection status and temporary-support review; depending on findings, it goes to the erection engineer, connection designer or primary structural designer. The two issues are linked because braced-frame work and roof equipment loads may interact in the construction sequence. Their resolution may change the order of erection or required observations.

The team then checks for downstream records. Has the material or piece-mark register changed? Do the affected weld and bolting details still match the governing design? Was preinstallation verification performed with the selected fastener assemblies? Are inspection hold points still reachable? Is there a revised engineered erection step before a crane is released? Does the closeout set include the actual penetrations, repairs and acceptance evidence? Closure occurs only when each line of the register has a verified final status. A single sign-off note is insufficient if it cannot be traced to the work and the controlling instructions.

3.7 Risk-based triage when time is limited

Field engineers should prioritize life safety, current stability and irreversible work. An erection-stage instability or suspected loss of a critical connection warrants immediate intervention through the site's authorized safety and engineering process. A fabrication piece-mark mismatch should stop installation of the affected material until reconciled. An incomplete but recoverable traceability record may require a documentation hold rather than destructive work if the necessary evidence can be obtained. A nonstructural cosmetic issue may follow a separate contract acceptance path. These categories are not judgments about blame; they direct attention and evidence to the decision maker.

A useful issue triage asks four sequential questions. Is the current condition safe to maintain under the approved temporary plan? What controlling requirement does the condition conflict with? Who is authorized to accept or redesign it? What objective evidence will show the final disposition was executed? If the first answer is unknown for a critical load path, work must not proceed on the assumption of safety. If the remaining answers are not known, create a record and assign the issue rather than silently allowing it to disappear in the next drawing revision.



Figure 10. Priority is determined by present stability and the engineering authority needed to resolve the condition.

Module 3 | Applied engineering workshop

Spend 20 minutes using Worksheet C. At a hypothetical 20-ft span, one end-plate connection does not align and a subcontractor requests permission to ream holes immediately. The bolt lot is unconfirmed, and a crane is supporting a beam while temporary lateral restraint is being installed. Write a two-stage response: what is necessary to maintain immediate safety, and what evidence and approvals are necessary before rework/installation resumes? Specify at least six records in the closeout packet. Your response should distinguish contractor-controlled temporary methods from structural engineering acceptance and method-specific bolt inspection requirements.

Five-minute consolidation

Explain why a complete-service steel-frame analysis cannot be used automatically for an intermediate erection stage. List four pre-installation checks and four post-connection records. Explain why a correct final count of bolts cannot compensate for an unapproved hole change. Refer to Technical Sources [1], [2], [4] and [6].

Applied engineering worksheets

These reproducible worksheets are intended for structured, independent decision-making. Write out the evidence and authorization chain before checking any action as complete. The worksheets are learner activities, not examination questions, construction specifications, or evidence of professional authorization.

Worksheet A | Controlled shop drawing release (25 minutes)

Situation: S-401 Rev 3 and B-118 Rev 2 disagree on member mark, gage, installation category and field weld. Use the worksheet to list each issue, classify its potential effect, and identify the required resolution. State whether the piece can be released, under which specific conditions, and how the revised instructions reach fabrication and erection.

Controlled issue and evidence register | Worksheet A

Finding / location	Controlling requirement	Hold, owner and authority	Evidence and closeout

Decision field	Learner statement / supporting record
Release statement	
Authorized decision / supporting record	

Decision record: Based on available information, hold the affected work until the discrepancy is reconciled. A mere shop-review stamp does not authorize a new connection design. Verify revised drawings and roles before releasing any specific piece mark.

Worksheet B | Fabrication acceptance and corrective action (25 minutes)

Situation: Material identity is incomplete, welding qualifications do not match the planned operation, and installation records for pretensioned bolts are inadequate. Keep three separate issue lines. Do not treat unavailable records as proof of a specific failed connection; also do not accept work that has not demonstrated the applicable requirements.

Controlled issue and evidence register | Worksheet B

Finding / location	Controlling requirement	Hold, owner and authority	Evidence and closeout

Decision field	Learner statement / supporting record
Release statement	
Authorized decision / supporting record	

Decision record: Each issue requires recorded containment and evidence or an authorized technical disposition. For material, reconnect physical identifiers to required certifications. For welding, confirm applicable WPS and welder qualification before continuation. For bolting, confirm the joint requirement, assemblies, verification and installation evidence.

Worksheet C | Field hold, engineered disposition and closeout (20 minutes)

Situation: Connection holes do not align while a beam is under controlled temporary support. The bolt lot and proposed reaming are unresolved. Document immediate stability, assignment of engineering responsibility, corrective authority, inspection method and closeout evidence.

Controlled issue and evidence register | Worksheet C

Finding / location	Controlling requirement	Hold, owner and authority	Evidence and closeout

Decision field	Learner statement / supporting record
Release statement	
Authorized decision / supporting record	

Decision record: Hold the modification and maintain the work safely under the approved erection plan. Verify actual geometry and records; obtain any required engineered change before rework; then reinspect to the revised criteria and link the closeout to the original issue.

Glossary of practice terms

Approval document: A project submittal or record subject to the review and approval process defined in governing documents; it does not automatically override the contract.

Connection designer: The engineer assigned to design a steel connection, either as part of the primary structural design or through defined delegated engineering.

Erection drawing: A drawing used to identify and locate members and field connections for assembly of the steel structure.

Faying surface: A contact surface between connected plies, particularly consequential to the slip resistance of a slip-critical bolted joint.

Fabrication traveler: A controlled production record tying a piece mark to material, operations, inspections and release status.

Heat/lot traceability: The documented association of material used in fabricated components with identifying production records and certifications, as required.

Inspection and Test Plan (ITP): An agreed schedule of required checks, methods, participants, hold/witness points, evidence and release authority.

Mill Test Report (MTR): A manufacturer record of specified material identification and test properties, subject to the relevant product standard.

Nonconformance record (NCR): A structured record of a deviation from a governing requirement, its containment, disposition, correction and verification.

Nondestructive testing (NDT): Examination methods such as ultrasonic, magnetic-particle or penetrant testing that evaluate defined indications without ordinarily destroying the component.

Preinstallation verification: Method- and assembly-specific checks used to confirm an appropriate structural-bolt pretensioning procedure before production installation when required.

Pretensioned joint: A structural joint requiring the specified bolt pretension under its governing specification; not equivalent to a generic high torque value.

Quality assurance (QA): The independent or separately assigned verification or oversight required to demonstrate compliance with project provisions.

Quality control (QC): Producer-performed controls and inspections to ensure fabricated or erected work conforms to requirements.

Request for Information (RFI): A controlled request for clarification or direction when project documents or conditions are incomplete, conflicting or changed.

Shop detail drawing: A fabrication-focused drawing recording member marks, geometry, materials, connection and production requirements derived from the controlling design.

Slip-critical joint: A bolted joint designed to resist slip through specified pretension and faying-surface characteristics under the applicable criteria.

Snug-tightened joint: A joint installed to achieve the firm-contact condition specified for its joint category; not interchangeable with a pretensioned joint.

Weld Procedure Specification (WPS): A document defining applicable welding process variables and requirements for performing the work.

Welding Procedure Qualification Record (PQR): A test record supporting qualification of a WPS when procedure qualification is required; distinct from the welder's performance qualification.

Technical sources and edition control

[1] American Institute of Steel Construction (AISC). ANSI/AISC 360-22, Specification for Structural Steel Buildings, plus applicable posted errata through September 2026. AISC 360-22 source

[2] AISC. ANSI/AISC 303-22, Code of Standard Practice for Steel Buildings and Bridges, plus applicable posted errata through September 2026. AISC 303-22 source

[3] AASHTO/NSBA collaboration through AISC. G1.1-2020, Shop Detail Drawing Review/Approval Guidelines for Fabricated Structural Steel. Primarily bridge oriented; referenced for the discipline of coordinated shop drawing review, not as a blanket building-project requirement. AASHTO/NSBA G-documents

[4] Research Council on Structural Connections (RCSC). Specification for Structural Joints Using High-Strength Bolts, June 5, 2025. RCSC specifications

[5] American Welding Society (AWS). D1.1/D1.1M:2025-AMD1, Structural Welding Code—Steel (2025 edition with Amendment 1 and applicable errata). AWS D1.1 standard

[6] AISC. AISC 207-25, Standard for Certification Programs (effective February 1, 2026, per AISC's current-standards site), and 2026 program governing requirements where applicable. AISC 207-25 source

The standards above are authoritative references for checking individual contractual and technical requirements. This course paraphrases high-level procedures and decision pathways; it does not reproduce detailed code tables, establish an acceptable weld defect limit or bolt tension, confer inspector qualifications, or supersede requirements for licensed engineering judgment or site-specific means and methods.