

## Field Inspection of Reinforcing Bars

### Introduction

In an ideal world, quality control or inspection to assure compliance with project drawings\*, project specifications, material standards, and building codes would not be necessary because the project drawings and project specifications would be complete without errors or omissions, the materials would be manufactured exactly to the material standards, and the field workmanship would be precise. However, in the real world, quality control programs are recommended, with inspection usually mandated to ensure compliance with a regulatory agency's policies. Why is this necessary?

Project drawings are not always complete due to an owner's desire for a rapid start and completion of a project. Materials may not meet the standards due to variations in the raw material or the manufacturing process. Workmanship is not always accurate due to improper training, inadequate experience, or careless supervision. Thus, there is recognition by owners, contractors, architects/engineers, and regulating agencies that programs for quality control and inspection are necessary to ensure compliance with the contract documents and the building code applicable to the project under construction.

The benefits of a quality control program and mandated inspection are mainly monetary, but they also ensure structural safety and compliance with architectural requirements. The owners, private and governmental, benefit with lower total costs, on-time construction schedules, and quicker occupancy. The architect/engineer benefits in the knowledge that the structure will conform to the design intent. The contractor, his subcontractors and suppliers, and all of their employees will benefit in a similar manner. The public, as the ultimate consumer and user of the structure, benefits in the knowledge that the structure has been built according to the project drawings and specifications.

The improper placement of reinforcing steel can greatly affect the strength and service life of a structure. This could lead to reduced structural performance, whereby the structure can no longer be used in the manner in which it was intended. In the transportation field, where the concrete elements are exposed to the environment, costly repairs and early replacement of structures have been too common and are often caused by improper reinforcing steel placement. A better understanding of the reasons for proper reinforcement placement and how to inspect reinforcement in the field will hopefully reduce the need for costly repairs and possible early replacements of structures falling short of their service life.

### Inspector Qualifications

Inspectors are individuals qualified to perform the inspection tasks. Through education, training, and experience, they should have the ability to read and understand project specifications, material standards, project drawings, and building code requirements. In the event of field problems, they must work with the contractor and make decisions on improvised details if the architect/engineer is unavailable to provide direction. An inspector must project confidence in his decisions. He should be meticulous, correct, fair, and firm, along with the ability to compromise when faced with a dispute regarding a conflict in the contract documents or actual field conditions, or both.

### Inspection Goals

The goal of any inspection or quality control program is to ensure that the intent of the contract documents is met and the applicable requirements of the building code are followed. Inspection and testing by themselves do not add quality to the product or the material being inspected, but only confirm whether or not what is being inspected meets the criteria established by the project drawings, project specifications, and building code.

Quality during the construction process is achieved almost entirely by the contractor's quality assurance program, which depends on

\* See the Terminology section on Page 7 for definitions of certain terms used in this report.

and involves all workers and field supervisors. The contractor's inspectors are his employees and are separate from the inspectors mandated by the owner or local building department. The quality control inspection by the contractor helps ensure that the finished construction meets the owner's requirements, while similar programs by the material producers and suppliers ensure that the products and materials being supplied will meet the specific requirements of the material standards. The final in-place acceptance inspection is a formalized procedure providing the owner and regulatory agency with an acceptable degree of assurance that the contractor has satisfied his obligations as described in the contract documents and by the building code. To accomplish this end, the inspector must be familiar with the project specifications and project drawings, have reasonable knowledge of the building code requirements, have access to material standards and reference codes, and have available industry manuals and reports. See "Applicable References" at the end of this Technical Note.

At the start of a construction project, whether small, medium or large, it is recommended that the inspector establish an inspection program for the reinforcing bars. The program can be established at a pre-construction conference with the general contractor's superintendent, the supplier's representative, the ironworker foreman, and other interested parties, such as the architect/engineer or the architect/engineer's inspector. This meeting should establish a checklist procedure and minimum requirements for inspection acceptance.

## Checklist

The checklist for the inspection of reinforcing bars should include, but not be limited to, the following:

- a. Construction Schedule:** A construction schedule from the general contractor is important and necessary so the inspector can follow the reinforcing bar placing crew and carry out an inspection of the in-place reinforcing bars prior to the scheduled placing and finishing of the concrete.
- b. Certified Mill Test and/or Bar Coating (Certification) Reports:** These reports may accompany the shipments of material to the job-site, and thus should be available to the inspector. In the event the reports are sent to the contractor's office rather than to the job-site, arrangements should be made to make them available to the inspector.
- c. Independent Testing Laboratory Reports:** The reports on samples taken either at the reinforcing bar fabricator's shop or from material shipped to the job-site, offer supplemental verification of the producer's mill test report.

**d. Approved Placing Drawings:** The latest approved placing drawings should be available for review and study by field placing personnel and the inspector at least one day prior to the actual placing of the reinforcing bars.

**e. Material Shipment:** A schedule of anticipated delivery dates should be provided and updated as necessary so the inspector can schedule an in-place inspection and review any reinforcing bar material tags.

**f. Potential Concerns:** A discussion between all parties is desirable to identify difficult-to-place reinforcement details, lack of specific details or information on the contract documents, possible structural drawing discrepancies, detailing or placing errors, and verification and acceptability of implemented field changes.

**g. Tolerances:** A discussion with all parties is necessary regarding which tolerances are critical, the method of measurement, and the basis for either rejection or acceptance.

**h. Periodic Meetings:** It is recommended that regularly scheduled meetings be held in order to discuss the previous inspection reports, any problems that were encountered, solutions to the problems, and the schedule of work for the next period.

## Material Verification

In-place inspection of reinforcing bars starts with the mill test report, which in some cases is supplemented by a report from an independent testing laboratory. Both reports should provide data as to grade of steel, tensile properties (yield strength, ultimate tensile strength, and percentage of elongation), bend tests, chemical composition and carbon equivalent (C.E.) in the event the reinforcing bars are to be welded, and the spacing and height of deformations. The reported data should meet the requirements of the applicable ASTM standard. A visual examination of the mill markings on a bar will identify the producing mill, the bar size, the type of steel, and the grade of steel.

## Inspection of In-Place Reinforcing Bars

Inspection of the reinforcing bars installed in the forms is done by visually examining the layout pattern, measuring the spacing, and counting of bars. The bar diameter and the bar shape, if bent, can be visually checked. Bar lengths, bar spacings, embedments, and bearings on walls or beams are normally checked by measurement. In a slab, the total number of pieces can be counted with the spacing of the slab bars verified by measurement, all checked against the approved placing drawings in conjunction with the structural drawings. Similarly, beam longitudinal bars, column vertical bars, and stirrup and tie spacings are checked visually and by measurement, as required.

**Bar Supports** — At the same time the beam and slab reinforcing bars are being inspected, the heights of bar supports should be measured to verify that the concrete cover and clearances will be as specified. It is extremely important that the bar supports for slab or mat top bars be checked not only for height but also for stability, because they can easily be displaced during the placement of concrete. In fact, the entire mat and cages of reinforcing bars should be evaluated for stability for the same reason. If the project specifications require corrosion-protection measures, the class of protection of the bar supports furnished should be verified.

**Tying Requirements** — Reinforcing bars are tied together to form a rigid mat for footings, walls, and slabs. A cage is formed when beam or column longitudinal bars are wire-tied to the stirrups or ties, respectively. Ironworkers are usually instructed to tie a minimum number of intersections. Unless the project specifications are very specific about the number of intersections to be tied, it is safe to assume that the bars have been adequately tied unless it is apparent that the mats or cages of reinforcing bars will be displaced from their inspected position during the placement, screeding, and finishing of the concrete. The placer is responsible for tying reinforcing bars in such a manner that the bars will not be displaced. The inspector should only verify and concur that this condition has been achieved. Only coated tie wire should be used to tie coated reinforcing bars.

CRSI's publication, *Placing Reinforcing Bars*, the authoritative publication on placing practices, states in its Chapter 10 under General Principles of Tying Reinforcing Bars:

"...It is not necessary to tie reinforcing bars at every intersection. Tying adds nothing to the strength of the finished structure..."

### Surface Condition of Bars

Generally, rust and mill scale on reinforcing bars should not be a cause for rejection by the inspector. The ASTM standards and the ACI 318 Building Code describe how to inspect and evaluate rusted reinforcing bars. However, dirt, grease, or other deleterious materials on the bars, i.e., materials that can affect bond, must be removed prior to concrete placement. Tests have indicated that water soluble cutting oils, those used when threading ends of bars for attaching to mechanical splices, do not significantly affect bond.

### Damage to Bar Coating

If epoxy-coated, zinc-coated (galvanized), or dual-coated reinforcing bars are specified for corrosion protection, the project specifications should be studied to determine the criteria for acceptance or rejection in the event there is damage to the coating. Any corrective actions should follow recommended repair procedures and be completed prior to acceptance by the inspector.

## Tolerances

No structure is built exactly level, plumb, straight, and true to line. Tolerances are the means used to establish permissible variations in dimensions and locations. Thus, the architect/engineer, contractor, and inspector have parameters within which the work can be performed and inspected. Tolerances should neither be overly restrictive nor lenient. The contract documents should specify the standard tolerances to be followed, usually by reference to the ACI 117 Specification. Judgment on the part of the inspector will establish a range of acceptability. Incompatible tolerances should be referred to the architect/engineer for resolution.

**Fabricating Tolerances** — Fabricating tolerances for reinforcing bars are established in the ACI 117 Specification, the ACI *Detailing Manual*, and the CRSI *Manual of Standard Practice*. Shearing length tolerance for straight bars is plus or minus 1 inch. The out-to-out dimension of bars with hooks or bends at one end or at both ends is plus or minus 1 inch. Stirrups, hoops, and ties that fit into a beam or column form, for #3, #4, and #5 bars (#10, #13, and #16 bars), with a gross length of 12 ft-0 in. or less, have a tolerance of plus or minus 1/2 inch. When the gross length exceeds 12 ft-0 in., the tolerance is increased to plus or minus 1 inch.

**Placing Tolerances** — Placing tolerances recognize the imprecise nature of the placing operation and allow deviation criteria. The ACI 117 Specification indicates tolerances on clear distance to side forms and resulting concrete surfaces, and on the clear distance to formed concrete soffits in the direction of the tolerance. These tolerances are:

<u>Member Size</u>	<u>Tolerance</u>
≤ 4 in.	± ¼ in.
> 4 in. and ≤ 12 in.	± ⅜ in.
> 12 in.	± ½ in.

The ACI 117 tolerances for concrete cover measured at right angles to the concrete surface in the direction of the tolerances are:

<u>Member Size</u>	<u>Tolerance</u>
≤ 12 in.	— ⅜ in.
> 12 in.	— ½ in.

Reduction in concrete cover is permitted by ACI 117. Generally, the reduction should not exceed one-third of the specified cover. For formed soffits, the reduction in cover is limited to ¼ inch.

The uniform spacing or center-to-center distance between reinforcing bars in slabs and walls have a tolerance of 3 inches from a specified location. The tolerance in the longitudinal location of bends and ends of bars, in general, is plus or minus 2 inches, but at a discontinuous

end of a structural member the tolerance is reduced to plus or minus 1 inch. At the discontinuous ends of corbels and brackets, the tolerance is plus or minus ½ inch. The tolerance for embedded bar length and length of bar laps is minus 1 inch for #3 to #11 bars (#10 to #36 bars) and minus 2 inches for #14 and #18 bars (#43 and #57 bars). In terms of percentages, these tolerances may be considered liberal, and normally are easily met. A longer splice length would be considered safer, hence there is no plus tolerance.

The tolerance for deviations from cross-sectional dimensions, except slabs, are:

<u>Specified Dimension</u>	<u>Tolerance</u>
≤ 12 in.	+ ⅜ in., - ¼ in.
> 12 in. and ≤ 36 in.	+ ½ in., - ⅜ in.
> 36 in.,	+ 1 in., - ¾ in.

The tolerance for the thickness of suspended slab is - ¼ in.

A potential problem occurs if the stirrups or ties are fabricated to the plus tolerance of ½ inch when the forms are made to the minus tolerance of ⅜ inch. This condition has the effect of reducing the clearance to 7/16 inch on each side of the stirrup or tie. The inspector must determine whether or not this encroachment on concrete cover is critical. As previously stated, the ACI 117 Specification permits a reduction in concrete cover of ⅜ inch when the member size is 12 inches or less, and ½ inch if the member is over 12 inches in the direction of tolerance. This type of problem should be resolved with the assistance of the architect/engineer.

Another example of encroachment on concrete cover is a formed footing; the horizontal form tolerance is plus 2 inches and minus ½ inch, while the tolerance on the reinforcing bars, either straight or bent, is plus or minus 1 inch. Again, if the forms are 'minus' and the reinforcing bars are 'plus', the concrete cover at each end of the bars is reduced from 3 inches to 2 ¼ inches. However, this condition would be acceptable, because the allowed reduction in concrete cover is 1 inch for sizes of structural members in excess of 2 feet.

In another example, the length of a beam which is discontinuous at each end may create a problem if the formwork is 'minus' when at the same time the reinforcing bars are 'plus'. Each trade, carpenter and ironworker, can claim that their work is within tolerance, thus giving the responsibility to the inspector to make a decision. The inspector must determine whether the encroachment on concrete cover is detrimental to the safety and service life of the structure, or is within the allowable limits of reduction in concrete cover.

Inspection of reinforcing bar placement in walls and slabs is usually straight forward and normally no mis-

placement will be found. Small openings, pipe sleeves, electrical outlets, and similar items may interfere with the specified location of the reinforcing bars, but the ironworker usually will shift the reinforcement to one side to avoid the obstruction. The ACI 117 Specification allows a maximum deviation from the specified location of 3 inches. This deviation normally is sufficient, provided that the total number of bars in a wall or slab panel is not reduced. No cutting of reinforcing bars should be performed to clear obstructions without approval by the architect/engineer.

The ACI 117 spacing tolerance for stirrups measured along a line parallel to the stirrup spacing is the lesser of plus or minus 3 in., or plus or minus 1 in. per ft. of beam depth. For column ties, the requirements are the same except the least column width is the key dimension instead of beam depth. Thus, stirrup or tie placement in an 18-inch square beam or column could vary from the specified location by 1½ inches.

### **In-Situ Bending and Rebending\***

The practice of bending and rebending installed reinforcing bars is often questioned. Many conditions and situations at the job-site require such bending and rebending. As an example, the horizontal leg of bent reinforcing bars (fabricated) projecting from a wall to become the top bars of a beam may have been improperly placed too low or too high, well in excess of concrete cover and placing tolerances. These bars will require 'straightening' and then 'rebending' to the proper position. The inspector, after consultation with the architect/engineer, should approve the procedure used to accomplish the task. Section R7.3.2 in the Commentary of the ACI 318 Building Code presents guidelines for straightening and rebending embedded reinforcing bars. Section 3 in the ACI 301 Specification includes provisions for field bending or straightening of reinforcing bars.

In some instances, the use of planned pre-bent dowels is requested by the contractor. The architect/engineer should review the request and notify the inspector. Similarly, straight dowels may be planned to be field bent into place, such as an outside face wall where vertical bars will be bent horizontally to become the slab end top bars. This procedure is intended to facilitate slab formwork erection. Again, the architect/engineer should review the procedure and notify the inspector. The inspector should discuss the bending procedure with the placing foreman to ensure that the bends conform to the ACI 315 Standard. Where large diameter bars are involved, some amount of heating may be recommended

\* This subject is not related to the fabrication of reinforcing bars. Fabrication of reinforcing bars is the cutting-to-length of straight bars, and cutting-to-length and bending-to-shape of bent bars. The issue here is concerned with bending and straightening or rebending of reinforcing bars that are partially embedded in hardened concrete.



by the architect/engineer to avoid the potential for brittle failure during bending.

### Field Cutting of Reinforcing Bars

An issue often occurring on construction projects concerns the cutting of reinforcing bars. The cutting envisioned in this discussion is unplanned cutting. It is not the kind of cutting associated with field fabrication of reinforcing bars. CRSI discourages field fabrication.\*

Field cutting of reinforcing bars would be required, for example, when bars are too long as a result of design changes, or when errors were made in detailing, fabrication, or placing. The field cutting could involve overlength bars prior to their placement in the forms or overlength bars that are partially embedded in hardened concrete.

Various means are used for field cutting. For smaller size bars, #3, #4, and #5 (#10, #13, and #16), the cutting can usually be accomplished with bolt-cutters. All bar sizes can be cut with a portable band saw, a reciprocating saw, or by flame-cutting with an oxy-acetylene torch.

From CRSI's experience, questions are likely to surface regarding the suitability of flame-cutting, i.e., will flame-cutting affect the reinforcing bars? The answer is "No." This is supported by a testing program that was undertaken to investigate the effect of flame-cutting reinforcing bars. In the testing program:

- Bar sizes #5, #8, #11, and #18 (#16, #25, #36 and #57) were investigated.
- The test bars were Grade 420 [minimum yield strength  $f_y = 420$  MPa or 60,900 psi; Grade 420 is the metric counterpart of Grade 60.]
- The test bars were carbon-steel conforming to ASTM A615/A615M, and low-alloy steel conforming to ASTM A706/A706M.

The results of the testing program showed that any effect of flame-cutting is localized to the end-cut surfaces. Only a very short distance or length of bar, approximately 3/16 inch, from the flame-cut ends is affected. Hardness testing was used to evaluate the effects of the flame-cutting on the tensile properties of the bars. From an analysis of the hardness test data, it was concluded that flame-cutting had no adverse effects on the bars.

Flame-cutting of epoxy-coated reinforcing bars is not recommended. Coating damage can be minimized by using other means of cutting rather than flame-cutting.

After cutting epoxy-coated reinforcing bars, the cut ends should be coated with the patching material used for repairing damaged coating. Damaged epoxy coating in the vicinity of the cut ends should also be properly repaired.

### Splices

**Lap Splices** — The location and length of lap splices has always been a concern of the architect/engineer, estimator, detailer, placer, and inspector. The ACI 318 Building Code states that the design drawings shall show the location and length of lap splices. The ACI 315 Standard repeats the above requirement and further instructs the detailer to follow the architect/engineer's details, thus both the placing drawings and the structural drawings should show the same location and length of lap splices. Chapter 12 of the ACI 318 Building Code contains provisions for determining tension lap splice lengths. Lap splice lengths will vary due to concrete compressive strength, yield strength of the bars, bar spacing, epoxy coating, concrete cover, and other factors. The inspector should make certain that the specified lap splice lengths are for the strength criteria of the materials furnished to the job-site, and that the placer follows the placing drawings. Also, longer lap splice lengths are usually not detrimental.

**Mechanical Splices** — The ACI 318 Building Code requires the architect/engineer to show the type and location of mechanical splices on the design drawings. If a full mechanical splice is required, the inspector should make certain that a compression-only mechanical splice is not furnished in error. In all cases, inspection should verify that the splice manufacturer's installation procedures and any instructions in the project specifications are followed. Dowel bar mechanical splices and lap-splice connector systems are used to replace pre-bent or other types of dowels which connect two separate pours of a reinforced concrete structure. The type and location should be approved by the architect/engineer.

**Welded Splices** — Welded splices of reinforcing bars present the same difficulty of inspection as welded structural steel connections. The ACI 318 Building Code (Section 3.5.2) states: "...Type and location of welded splices and other required welding of reinforcing bars shall be indicated on the design drawings or in the project specifications." Section 3.5.2 also requires: "Welding of reinforcing bars shall conform to 'Structural Welding Code — Reinforcing Steel (AWS D1.4/D1.4M)' of the American Welding Society."

It should be noted, under the AWS Welding Code, that the architect/engineer is not obliged to specify the welding procedures to be used. Rather the Welding Code requires the contractor to prepare written welding procedure specifications (WPS's) for the welded splices.

\* According to the CRSI Manual of Standard Practice, "It is recommended that all reinforcing bars be shop fabricated and so specified by the architect/engineer, as operations can be performed with greater accuracy in the shop."

Regarding inspection activities at the job-site, the inspector should review the mill test reports for the reinforcing bars to determine the carbon equivalent (C.E.), and verify the preheat requirements. The inspector should be aware that both types of generally-available reinforcing bar, ASTM A615 (carbon-steel) and ASTM A706 (low-alloy), can be welded as per the AWS D1.4 specification. The difference between welding these two types is that A615 bars, depending on the C.E., could require preheating up to 500° F, while A706 bars will probably not require any preheating. Other types of reinforcing bars are available, but these are the common types in building construction.

The inspector should verify the welder's certification, confirm that the correct electrodes (oven dry) are available, and that the preheat temperature crayon sticks are on hand. Continuous inspection is usually specified to ascertain that the welder uses the proper number of passes, controls the interpass heat loss, and uses a wire brush and chipping hammer to remove any slag.

For some projects, the contract documents will require radiographic inspection of the welded splices. This procedure is time consuming and costly, and can be inconclusive. More often a test specimen located at random is removed for a laboratory tension test and analysis.

**Welding of Crossing Bars** – The inspector should not allow field tack welding of reinforcing bars, i.e., welding of crossing bars, as a means for assembly of reinforcement. Tack welding can embrittle the steel, which reduces strength and can also have a detrimental effect on ductility and fatigue resistance. Field tack welding is not a substitute for wire tying the assembly of reinforcing bars.

For information on shop-welded assemblies of reinforcing bars, see EDR No. 53 “Assembling Reinforcing Bars by Fusion Welding in the Fabricating Shop.”

## Conclusions

All the foregoing discussion indicates that the inspector has a formidable assignment when inspecting in-place reinforcing bars. This impression is not necessarily true, but it is an exacting task, one that assures the workers perform their job to the best of their ability. However, mistakes can and will happen, but an inspector is expected to find them and have them corrected. All parties involved in a construction project, from the architect/engineer to the contractor, attempt to do error-free work. A quality control program by the contractor helps in achieving this goal, which makes final inspection easier. The inspector should not perceive his role as adversarial, but as complementary to the workers in support of good construction techniques and practice. Good inspection is assurance of a properly built structure, one which all parties involved in the process can take pride.

For further information on inspection, tolerances, industry standard practices, fabricating, placing and splices, consult the following references.

## Applicable References

“Specifications for Tolerances for Concrete Construction and Materials and Commentary (ACI 117-10),” American Concrete Institute, Farmington Hills, Michigan.

ACI Detailing Manual — 2004, Publication SP- 66, American Concrete Institute. The standard “Details and Detailing of Concrete Reinforcement (ACI 315-99)” is included in the Manual.

“Building Code Requirements for Structural Concrete (ACI 318-08) and Commentary (ACI 318R-08),” American Concrete Institute.

“Specifications for Structural Concrete (ACI 301-10),” American Concrete Institute.

“Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement (A615/A615M-09b),” ASTM International, West Conshohocken, Pennsylvania.

“Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement (A706/A706M-09b),” ASTM International.

“Standard Specification for Epoxy-Coated Steel Reinforcing Bars (A775/A775M-07b),” ASTM International.

“Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars (A934/A934M-07),” ASTM International.

“Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement (A767/A767M-09),” ASTM International.

“Standard Specification for Deformed and Plain Stainless-Steel Bars for Concrete Reinforcement (A955/A955M-10a),” ASTM International.

“Standard Specification for Headed Steel Bars for Concrete Reinforcement (A970/A970M-09),” ASTM International.

“Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement (A996/A996M-09b),” ASTM International.

*Manual of Standard Practice*, 28th Edition, 2009, CRSI.

*Placing Reinforcing Bars*, 8th Edition, 2005, CRSI.

*Reinforcing Bars: Anchorages and Splices*, 5th Edition, 2008, CRSI.

"Using Soft Metric Reinforcing Bars in Non-Metric Construction Projects," Engineering Data Report No. 42, CRSI.

"Commonly Asked Technical Questions Concerning Cast-in-Place Reinforced Concrete Construction," Engineering Data Report No. 44, CRSI. [See discussion of Field Bending of Reinforcing Bars and Welded Splices of Reinforcing Bars.]

"Assembling Reinforcing Bars by Fusion Welding in the Fabricating Shop," Engineering Data Report No. 53, CRSI.

"Field Inspection of Reinforcing Bars", 25-minute CD, 2008, CRSI.

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International Building Code, 2009, International Code Council, Falls Church, Virginia.

Rylander, E., "Effect of Torch-Cut Rebar Ends on the CADWELD Splice," *Internal Report*, Erico Products, Solon, Ohio, June 1972, 6 pp.

Ameristeel Corporation, "Flame Cutting of Reinforcing Bars," *Internal Report*, Ameristeel Knoxville Steel Mill Division, Knoxville, Tennessee, April 1999, 10 pp.

## Terminology

The source of the following terms and their definitions is "Specifications for Structural Concrete (ACI 301-10)".

**Architect/Engineer or Engineer/Architect** — Architect, Engineer, architectural firm, engineering firm, or architectural and engineering firm issuing Contract Documents or administering the work under the Contract Documents, or both.

**Contract Documents** — A set of documents supplied by Owner to Contractor as the basis for construction; these documents contain contract forms, contract conditions, specifications, drawings, addenda, and contract changes.

**Project Drawings** — Graphic presentation of project requirements.

**Project Specifications** — The written document that details requirements for the Work in accordance with service parameters and other specific criteria.

**Work** — The entire construction or separately identifiable parts thereof required to be furnished under Contract Documents.

## Appendix A – Potential Project Submittal Items for Reinforcement

(adapted from ACI 301 — Specifications for Structural Concrete)

These items listed will be submitted by the Contractor and reviewed by the Architect/Engineer.

- Certified mill test reports on reinforcing materials.
- Placing drawings showing fabrication dimensions and locations for placement of reinforcement and supports.
- List of splices and request to use splices not indicated on the Contract Documents.
- Request to use mechanical splices not shown in the Contract Documents.
- Request for placement of column dowels without using templates.
- Request a procedure to field bend or straighten partially embedded reinforcing bars.
- Copy of CRSI Plant Certification and/or NTPEP Mill Certification, if applicable.
- Description of reinforcing bar weld locations, welding procedure specifications, and welder qualifications.
- Proposed supports for coated reinforcement and materials for fastening coated reinforcement.
- Request use of alternative reinforcement support type.
- When Contractor finds it necessary to move reinforcement beyond the specified placing tolerances to avoid interference with other reinforcement, conduits, or embedded items, review a submittal showing the resulting reinforcement arrangement.
- Inspection and quality-control program of plant that is not certified by Concrete Reinforcing Steel Institute.
- Provide equivalent certification program for evaluation by Architect/Engineer.
- Precast concrete support materials.
- Request to heat reinforcement before bending.
- Request to extend reinforcement through control joints, including saw-cut joints.
- Request to use an alternative method or setting column dowels.
- Request to use other method to measure preheat temperature.
- Request to field cut reinforcement.

## Appendix B – Suggested Checklist Items for Reinforcing Steel Inspection

### Prior to reinforcing bar placement:

- Obtain reinforcing bar tags and mill test reports.
- Check reinforcing bar tags for proper markings.
- Check delivered material against reinforcing bar schedules & drawings.
- Check bar markings and/or grade marks against CRSI's *Manual of Standard Practice*, Appendix A.
- Check reinforcing bar condition.
- Take material samples, as required.
- Check for coating damage in bundle; implement repairs before bar placement.
- Check storage of reinforcing bars. [Are all delivered reinforcing bars stored above the ground upon skids, platforms or other supports? Are epoxy-coated reinforcing bars stored on wooden or padded steel cribbing? Are the reinforcing bars protected from mechanical injury and from deterioration by exposure? For uncoated (black) bars, a light coating of rust should not be considered objectionable.]

### During/after reinforcing bar placement:

- Check reinforcing bar quantity, size, and location with plans or applicable drawings. Document as necessary.
- Check spacing before and after concrete placement.
- Check reinforcing bar concrete cover and clearances – vertical and horizontal.
- Check splice locations and splice lengths. If required, verify the lap lengths are at the minimum lengths.
- Check placement and adequacy of ties and supports. Verify tied bar junctions are adequately tied.
- Check for coating damage; patch if necessary.
- Verify bars are free of dirt, oil, rust, paint, etc.
- Are there any special trim reinforcing bars required at sleeves or openings, identified in "typical" details? (i.e. diagonal bars at corners, etc.)
- Is the reinforcement properly placed adjacent to construction joints?

- Check any reinforcement congestion concerns/problems, and evaluate prior to concrete placement.
- Where two or more separate mats of reinforcing steel are required, should each mat be independently supported by an approved support system?
- Check embedment lengths.
- Check all mechanical splices. Are the two bars entering the splice properly anchored (set screws torqued, grout installed, wedge set, etc.)?
- Hooks oriented properly?
- Headed bar anchors are installed and tight, so they will not displace during the concrete placement operation.
- Punching shear stud assemblies tied properly or attached properly to formwork?

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**Reference:** Concrete Reinforcing Steel Institute-CRSI [2011], "Field Inspection of Reinforcing Bars," *CRSI Technical Note CTN-M-1-11*, Concrete Reinforcing Steel Institute, Schaumburg, Illinois, 8 pp.

**Historical:** Formerly Engineering Data Report No. 54 (2004), which replaced EDR No. 49.

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