

Introduction and Document Usage



1.1 Introduction

Clarity of communication is at the heart of any successfully delivered building construction project. Owners and developers, jurisdictional plan reviewers and inspectors, architectural and engineering practitioners, construction managers and general contractors, and subcontractors and vendors: each is a project stakeholder occupying a distinct role characterized by a unique set of proficiencies. The effectiveness with which these proficiencies are respectively deployed will have a profound impact on how closely the finished building resembles the vision upon which the whole undertaking was originally based. Quite simply, poor communication breeds unfulfilled expectations.

The Welded Wire Reinforcement Design and Detailing Guide's target audience is two-fold. The first audience includes the practicing structural engineer and affiliated drafting technician. Each of these two professionals recognizes the need to balance well-communicated structural detailing with constructability of the detailed configuration through a repeatable contract document preparation and delivery routine. The second audience is the construction contractor.

The Focus of this guide will be on welded **deformed** wire reinforcement (WWR) in building type applications only, deferring the specification of welded plain wire reinforcement to other texts. Our objective is to provide to the designer and contractor alike a comprehensive benchmark for the incorporation of WWR into contract documents serving as the basis for construction on site. Material and manufacture requirements for WWR are defined in ASTM A1064 *Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete*.

This document provides WWR knowledge without compromising the current structural detailing process familiarity and comfort. If there is a theme that will be repeated throughout this document, it is one predicated on eliminating the notion that (a) the structural Engineer-of-Record (EOR) needs proprietary-like knowledge in order to implement WWR into their contract drawings, and (b) the protocol-in-use for reinforced concrete design and detailing should somehow be overhauled in order to accommodate WWR usage.

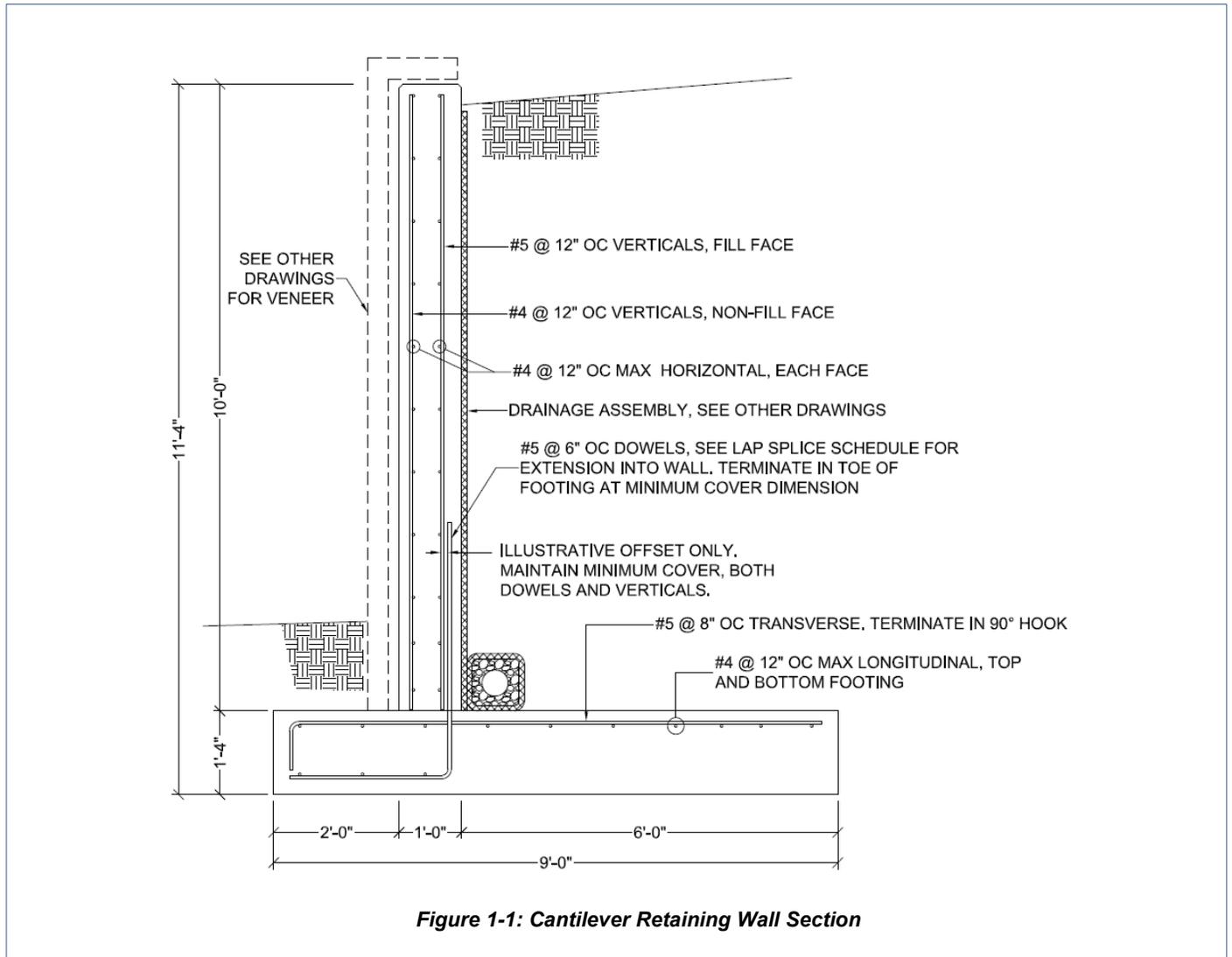
The Welded Wire Reinforcement Design and Detailing Guide ("The Guide") is specifically geared towards detailing of cast-in-place reinforced concrete building-type structures and related appurtenances that are designed in accordance with the provisions of the American Concrete Institute's ACI 318-19 "*Building Code Requirements for Structural Concrete*" Standard and ACI 318R-19 "*Commentary on Building Code Requirements for Structural Concrete*". Note that for the sake of completeness, *The Guide* also includes ground-supported slabs designed using ACI 360-10 "*Guide to Design of Slabs-on-Ground*" as the primary reference.

1.2 Detailing Guide Format and Presentation

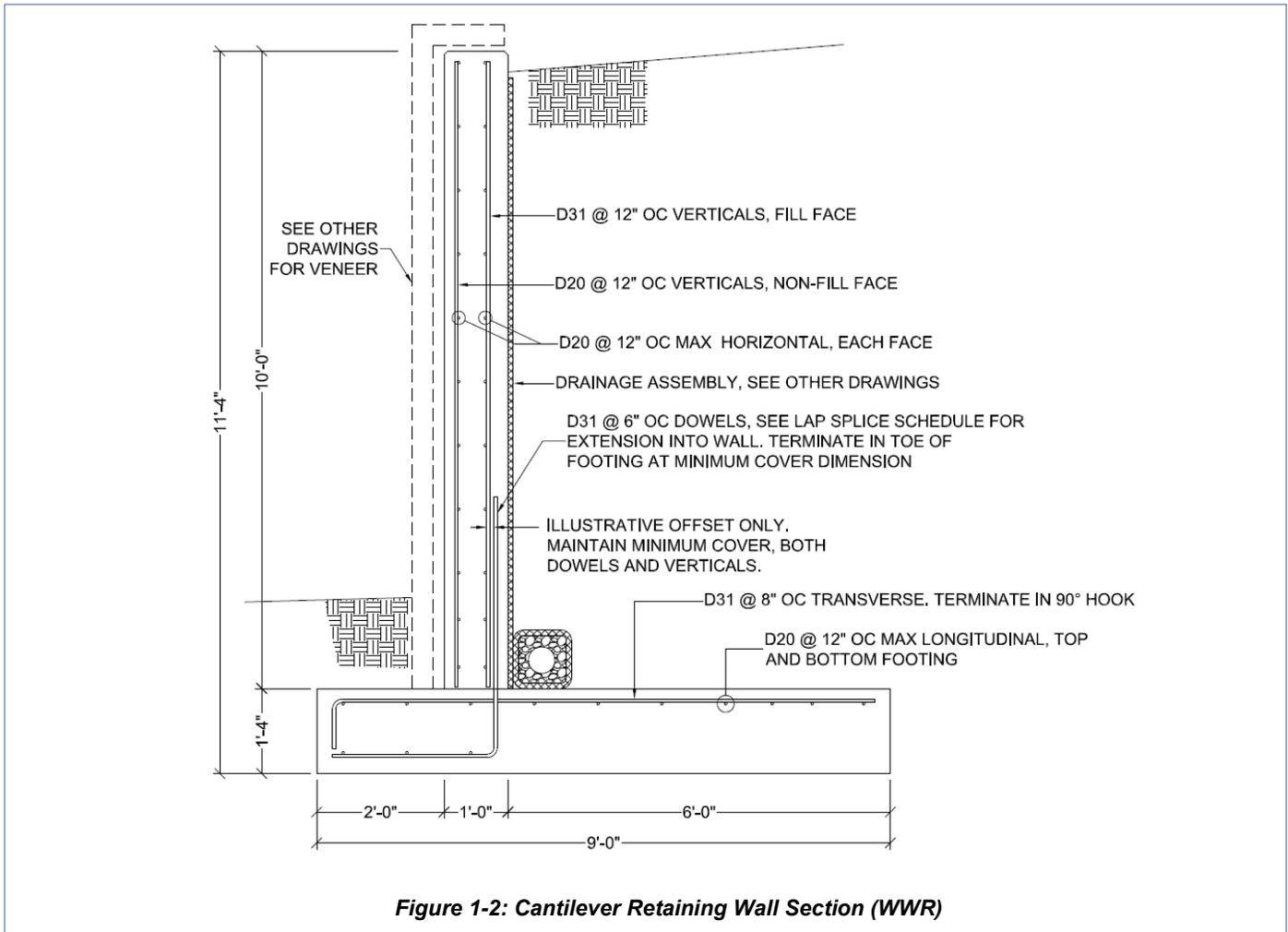
Design of cast-in-place building structures comprised of mild-reinforced structural concrete members and components is most commonly based on the use of individual deformed reinforcing bars (“rebar”) arranged manually in the field to achieve a specified pattern or configuration. There exist numerous prevailing factors that make the use of rebar the standard by which other structural reinforcements are judged, the details of which are beyond the scope of this guide, but suffice it to say that rebar is deformed reinforcement in its most basic and spatially intuitive form, having a longstanding default presence in engineering academia and practice.

In laying the groundwork for any technically meaningful discussion centered on WWR, it is critically important to acknowledge the role rebar continues to play in the structural design and construction communities. In the case of *The Guide*, this acknowledgement shapes the formatting of its content. Because structural design professionals are historically inclined to present their design intent through the use of details configured using deformed reinforcing bars as a default, any comparative reinforcement solution utilizing WWR will, at least in principle, be based on this same detailing methodology. This is illustrated below in the form of a comparative example.

Assume a structural engineer designs and subsequently details a fixed-free cantilever retaining wall. The detailed design intent is shown in Figure 1-1, using reinforcing bars:



What *The Guide* seeks to impress upon the structural engineering practitioner is that the leap required to go from a detail illustrating a rebar-based design to a detail invoking the usage of WWR is, in fact, not much of a leap at all, as shown in Figure 1-2 below:



When comparing the two figures, it is apparent that no “proprietary” knowledge of WWR is required on the part of the design professional. Geometries and alignment originally shown for rebar are maintained, and reinforcement call-outs are simply swapped to reflect rudimentary wire size (#4 rebar → 0.20 in² → D20; #5 rebar → 0.31 in² → D31). Similarly, directions on reinforcement spacing remain unchanged. These are quite literally identical details from a design intent and structural performance standpoint, and from the perspective of the practicing engineer and affiliated detailer, the change in routine is miniscule. In Chapter 2 we will touch on ACI 318’s acceptance of WWR that serves as the basis for the interchangeability shown above.

Showing rudimentary WWR inclusion in a “familiar framework” is a fundamental goal of *The Guide*, whether it be in the form of “Direct Specification” (as shown in Figure 1-2) or as a “Pre-Approved Equal” (See Chapter 4 for more information), it is also critical that an illustrative light be shined on downstream WWR detailing efforts – carried out by highly capable WWR producers and fabricators – so that the engineering reader is not left feeling as if the specification of WWR on structural contract drawings puts them on an island without a knowledgeable counterpart. To accomplish this, *The Guide* will provide design and detailing examples comprised of both the initial design effort itself and accompanying WWR fabrication drawing and relevant placement information excerpts. The inclusion of fabrication and placement information is intended to provide educational assurance to the EOR that her/his structural information is, in fact, being fleshed out in WWR form - by WWR detailers – for subsequent shop drawing review and contractor placement purposes.

For Figure 1-2, excerpts of its WWR shop drawing counterpart are reflected in Figure 1-3.

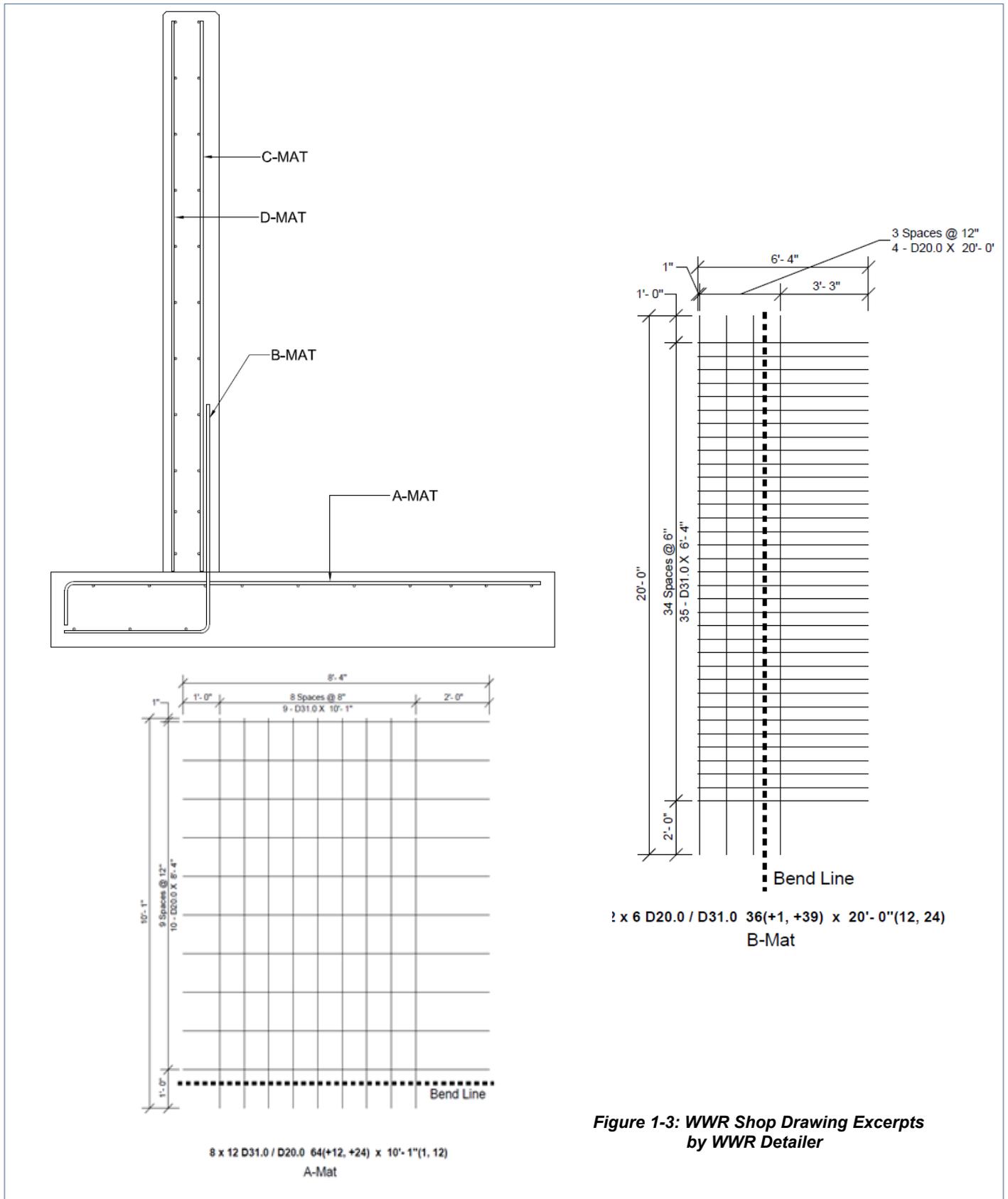


Figure 1-3: WWR Shop Drawing Excerpts by WWR Detailer

Using the above concept, the format and flow of Chapters 5 through 10 generally presents as follows:

- A. Project design criteria and the spotlighted reinforced concrete element**
- B. Structural design of the reinforced concrete element**
- C. Derivation of reinforcement areas and alignment**
- D. Engineer's WWR contract document requirements**
- E. WWR fabrication drawings**

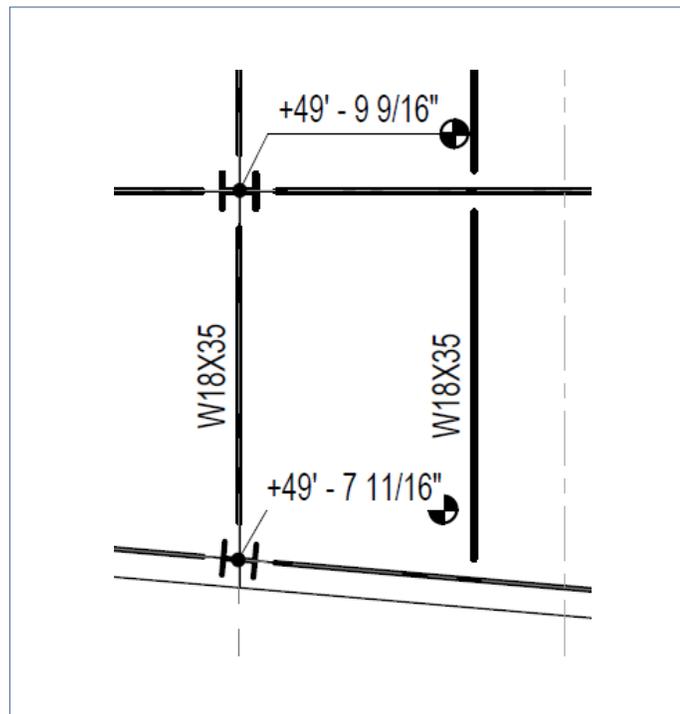
1.3 Catering to the Design Professional

In its efforts to provide WWR-based educational and technical guidance in past years, the Wire Reinforcement Institute has placed a heavy emphasis on the manufacturing process and material nomenclature itself. The hope was that WWR would become an integral part of the daily vocabulary of designer and contractor alike by creating contrast with hand-tied individual reinforcing bars.

These ongoing efforts have had significant success, most notably in the roadway precast, civil precast, and slab-on-ground markets. But in the cast-in-place concrete building structure market, the structural engineering community – in general – would prefer to avoid specifying “specialized” WWR criteria. While this information is critical to WWR manufacture, it is not relevant to conveying design intent on a set of detailed deliverables.

The irony is that structural steel is the primary competition to reinforced concrete when it comes to construction material.

In specifying the need for a W18x35 steel beam, structural contract drawings will indicate on the plan the following:



Now imagine a set of structural drawings with every W18x35 beam specified as follows:

W18x35 (6", 0.425") x (0.300", 17.7") x 22'-4"

As can be seen, the absence of certain implicit "turnkey" properties of manufacture is oftentimes preferred. From the designer's perspective, applied to WWR:

D31 @ 12" oc vertical, D20 @ 12" oc horizontal

vs.

12x12 D31/D20 60" (+12", +24") x 9'-10" (8,2)

Note that most of the information in the second option, even though interpretable by the EOR (WWR mat style nomenclature is explained in Chapter 3), is beyond his/her responsibility to define, as it is specific to manufacturing capabilities and preferred production geometries that best suit fabrication, shipping, and placement. Expecting the EOR to embrace the definition of explicit WWR mat descriptions on structural drawings is analogous to demanding that the engineer build into his/her structural details all of the rebar lengths and bar counts. It is unreasonable and misaligned with standard practice. It is also worth noting that if a design professional were to attempt to specify turnkey WWR mat styles without themselves having an intimate familiarity of the producing manufacturer's equipment capabilities and capacities, they could inadvertently create undesirable conflicts or delays when it comes time for the reinforcement to actually be procured, as the pre-specified, turnkey mat styles may not be feasibly manufactured.

In addition to *The Guide's* aim to keep the prospect of detailing WWR a simple and familiar affair for the EOR, it must also maintain focus on those structural reinforcement applications in a cast-in-place concrete building structure that are actually well-suited for WWR implementation, or else its usefulness is greatly diminished. Because WWR is produced in mat form and is comprised of deformed wires up to and including 5/8" diameter, it does many things very well. This will be demonstrated in the details of Chapter 5 through Chapter 10. In contrast, WWR would likely not be the ideal option to replace, say, five (5) #11 reinforcing bars used as bottom flexural reinforcement in a 24" wide floor beam. This sort of application – one that neither the structural engineer nor WWR manufacturer would be highly motivated to pursue using WWR – is, therefore, not presented in *The Guide*. Quite simply, there are applications for which rebar is, and will continue to be, the most natural fit, just as there are those where WWR would provide an exceptional solution through the eyes of both the designer and the contractor.

Usefulness of this document as interpreted by the design professional and construction professional is of paramount importance, as is the integrity of the information presented within. The interplay between WWR and rebar on the same project, and oftentimes in the same structural application, is candidly presented.

1.4 Why Welded Wire Reinforcement?

The allure of implementing welded wire reinforcement into a cast-in-place concrete building project resides almost exclusively in the field. The prospect of placing large quantities of reinforcement at significantly higher installation rates in comparison to individual, hand-tied rebar can be enticing for contractors seeking to streamline labor and reduce duration of placement operations that fall on the critical path. This speaks directly to the ever-tightening project budgets and accelerated construction schedules that pervade today's cast-in-place building structure landscape, combined with the ever-present challenge that is qualified labor shortage.

As will be shown throughout subsequent detailing chapters of this guide, the directly-tangible aspect of WWR implementation – *actually getting the WWR information on the structural contract drawings* – is a relatively elementary undertaking for an engineer. Despite this procedural simplicity, if the engineer tasked with deciding whether or not to implement WWR does so in a “designer's vacuum”, there may end up being little motivation to stray from rebar as the reinforcement of choice, even for those structural applications that are well-suited for WWR use. In contrast, if the engineer is engaged on the project in such a way that their proactivity is relied upon to contribute to improvement of project schedule, cost, and constructability, the return on investment of a decision to implement WWR can be significant. Not only do contractors hold in high regard a set of easily buildable contract documents, but the project owners reap obvious dividends as well.

1.5 A Complementary Document

The content of the *Welded Wire Reinforcement Design and Detailing Guide* is presented with the understanding that the engineering reader is already well-versed in structural design of reinforced concrete, structural detailing of reinforced concrete, or both, and that the contracting professional is equally proficient with regard to interpretation of material installation and placement drawing. *The Guide* is not intended to be a reinforced concrete design guide or code standard, nor is it intended to be a standalone resource for wholesale drafting methodology or construction tolerance and sequence. *The Guide* is best utilized as a complement document to design and detailing standard publications, creating value by offering detailing insights specific to the welded wire reinforcement product in a contract document preparation setting that is familiar and scalable to the reader.