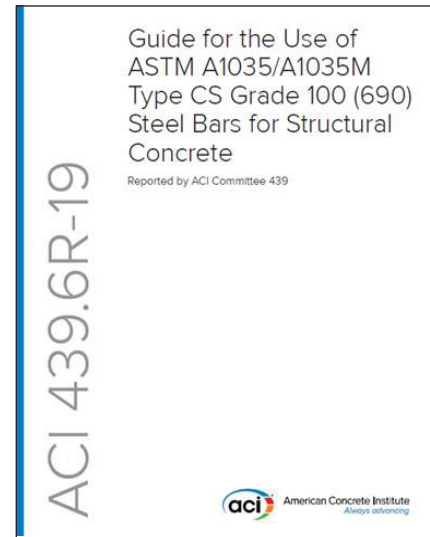


GUIDE FOR THE USE OF ASTM A1035/A1035M TYPE CS GRADE 100 (690) STEEL BARS FOR STRUCTURAL CONCRETE WHEN REFERENCING ACI 318 CODES PUBLISHED PRIOR TO ACI 318-19

This guide is based on ACI ITG-6R-10, “Design Guide for the Use of ASTM A1035/A1035M Grade 100 (690) Steel Bars for Structural Concrete,” reported in 2010 by the ACI Innovation Task Group 6. The ACI 439.6R-19 Design Guide provides design provisions for the use of ASTM A1035/A1035M Type CS Grade 100 (690) deformed steel bars in reinforced structural members. This guide, ACI 439.6R-19, is a stand-alone document that references and addresses only those requirements in ACI 318-14 that limit the use of such steel bars and should not affect the application of other code requirements. Any other ACI 318 version will be explicitly specified. This guide includes a discussion of the material characteristics of Grade 100 (690) ASTM A1035/A1035M Type CS (Chromium content 8.0 to 10.9 percent) deformed steel bars, and the design provisions are based on the specific material properties and stress-strain behavior of these bars.

Although there are limiting ACI 318 requirements, ACI 318-14 Section 1.10 would allow the use of high-strength reinforcement. “Sponsors...shall have the right to present the data on which their design is based to the building official or to a board of examiners appointed by the building official.”

The International Building Code (IBC 2012) would allow the same under Section 104.11, “Alternative materials, design and methods of construction and equipment”. To approve an alternative material under this section, a building department would typically require an ICC Evaluation Service (ICC-ES) Evaluation Report, which would be based on an ICC-ES Acceptance Criteria (AC) document. An AC document (ICC-ES AC429) and an Evaluation Report (ICC-ES ESR-2107) exist, permitting the use of ASTM A1035/A1035M Grade 100 reinforcement.



This guide includes a discussion of the material characteristics of Grade 100 (690) ASTM A1035/A1035M (CS) deformed steel bars and recommends design criteria for beams, columns, slab, systems, walls, and footings for Seismic Design Category (SDC) A, B, or C, and for structural components not designated as part of the seismic-force-resisting system for SDC D, E, or F.

Design examples are included to illustrate design procedures and proper application of the design criteria.

This document is available in Electronic PDF and can be purchased directly from the ACI Bookstore www.concrete.org/bookstorenet/.

AVAILABILITY

REBAR: #3 - #11,
#14, & #18
COIL: #3, #4 & #5

SMOOTH ROUND DOWELS:
1-1/4 & 1-1/2 inch
diameter

CUSTOM MILL-CUT LENGTHS:
Available by special order of 25 tons
or greater and a minimum length
of 20'

DESIGN GUIDE FOR THE USE OF CHROMX GRADE 100 (690) IN BUILDING STRUCTURES

The following design guidelines for use of ChromX Grade 100 (690) steel bars for structural concrete are presented herein based on the recommendations of the ACI 439.6R-19 report. Please refer to the ACI report for more details on these recommendations:

- A simplified design method is recommended for flexural tension, based on an idealized elasto-plastic stress-strain curve with a yield plateau at $f_y = 100$ ksi (690 MPa).
- The tension-controlled and compression-controlled strain limits and the strength reduction factor ϕ are adjusted to ensure satisfactory member behavior. The adjusted tension and compression strain limits are 0.009 and 0.004 respectively, and the adjusted strength reduction factor ϕ is given by the following equation: $0.65 \leq (\phi = 0.45 + 50\epsilon_t) \leq 0.9$
- Flexural and direct compression, f_y is taken as 80,000 psi (550 MPa).
- Moment redistribution for flexural design using ChromX reinforcement is not recommended.
- Flexural design using ChromX Grade 100 (690) bars with $f_y = 100,000$ psi (690 MPa) would result in higher steel stress at service load conditions; designer should exercise caution in applying the ACI 318 provisions on crack and deflection controls.
- For shear design of beams, ChromX Grade 100 (690) bars may be used as shear reinforcement with specified yield strength (f_{yt}) = 80,000 psi (550 MPa).
- Development and splice length for ChromX reinforcement in tension may be determined by ACI 318 equations provided the splice is confined.
- Design of slab systems using ChromX Grade 100 (690) steel bars should follow the provisions of ACI 318-14 for shear in one-way and two-way slabs.
- If shear reinforcement is required to provide sufficient shear strength for a two-way slab system, the f_{yt} for shear reinforcement should be limited to 60,000 psi (410 MPa).
- There are no exceptions from the requirements of ACI 318 for designs of columns, walls, footings and pile caps, and mat foundations using ChromX reinforcement other than the adjustments of f_y for tension and compression reinforcements, and f_{yt} for shear reinforcement, similar to the values used for beam design.
- The recommended specified yield strengths for design of various structural members using ChromX reinforcement are summarized for convenient reference in Table 1.

Table 1 - Specified Yield Strengths for Design of Members using ChromX Reinforcement

| Type of member | Longitudinal reinforcement (f_y) | | Transverse reinforcement (f_{yt}) | | |
|-------------------------|--------------------------------------|------------------------|---------------------------------------|--------------------|------------------------|
| | Tension, psi (MPa) | Compression, psi (MPa) | Shear, psi (MPa) | Torsion, psi (MPa) | Confinement, psi (MPa) |
| Beams and One-way Slabs | 100,000 (690) | 80,000 (550) | 80,000 (550) | 60,000 (410) | N/A |
| Columns | 100,000 (690) | 80,000 (550) | 80,000 (550) | 60,000 (410) | 100,000 (690) |
| Tension Ties | 80,000 (550) | N/A | N/A | N/A | N/A |
| Compression Struts | N/A | 80,000 (550) | N/A | N/A | N/A |
| Two-way Slabs | 100,000 (690) | 80,000 (550) | 60,000 (410) | 60,000 (410) | N/A |
| Walls | 100,000 (690) | 80,000 (550) | 80,000 (550) | N/A | 100,000 (690) |
| Footings and Pile Caps | 100,000 (690) | 80,000 (550) | 80,000 (550) | 60,000 (410) | N/A |
| Mat Foundations | 100,000 (690) | 80,000 (550) | 80,000 (550) | N/A | N/A |