# NYC BUILDINGS BULLETIN 2018-013
## ENGINEERING BULLETIN #10

**Through the issuance of the New York City Buildings Bulletin 2018-103 that supersedes Bulletin 2015-036, the city accepts designs employing the 100,000 psi yield strength of ASTM A1035/A1035M-16b rebar, clearing the way for applications of MMFX high strength ChromX® rebar and efficient high rise construction.**

**ChromX bars conforming to ASTM A1035/A1035M-16b are now:**
- The only 100 ksi reinforcement that can be used in Seismic Design Categories A, B and C
- The only reinforcement over 80 ksi that can be used in beams and slabs
- The only 100 ksi reinforcement that can be used in coupling beams and moment frame if it is not part of a special seismic system

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**Design Compliance:** Use of ASTM A1035/A1035M-16b shall comply with the NYC Construction Codes and the following Design Conditions:

- Structural design shall be in accordance with ACI 318 as modified by ACI ITG 6R-10, ICC-ES AC429 and the conditions of the NYC Buildings Bulletin 2018-036.
- Tensile properties shall be in accordance with the requirements of ASTM A1035/A1035M Specification.
- Design yield strengths should be in accordance with Table 1 of the ICC-ES AC429, specifically:

| | |
|---|---|
| **Flexure Strength computations:** | **100,000 psi** |
| **Compression Strength Computation:** | **up tp 100,000 psi** |
| **Shear Strength Computation:** | **80,000 psi** |
| **Shear for Torsion Computation:** | **60,000 psi** |

- Maximum yield strength of 60,000 psi shall be used in tension reinforcement in areas of slabs subject to punching shear.
- Modulus of rupture of concrete shall be in accordance with the following equation when considering deflection of 2-way slabs.

$$f'_r = 4\,\lambda\,\sqrt{f'c}$$

- Use of ASTM A1035 shall not be used as longitudinal reinforcement in special moment frame members, special structural wall boundary elements, coupling beams or members that are part of the seismic-force-resisting system of a building assigned to Seismic Design Categories D, E or F.
- Designs using ASTM A1035/A1035M shall be subject to peer review.
- As per ASTM A1035/A1035M specifications, no welding protocols are available. Similar to other reinforcing bars, the steel should not be welded.
- Mechanical splices must be demonstrating that stresses of 140 ksi can be developed with an evaluation report issued in accordance to ICC-ES AC429. Headed mechanical anchorage shall only be used when approved by the commissioner.
- Development and lap splice lengths should be determined in accordance with the modified equation using yield stress of 140 ksi as shown in the Table on the next page.

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# DETERMINING THE PROPER DEVELOPMENT LENGTH FOR LAP SPLICING HIGH STRENGTH CONCRETE REINFORCEMENT AS PER NYC BUILDINGS BULLETIN 2015-036

The process for determining the development length of ASTM A1035/A1035M Grade 100 rebar is consistent with conventional reinforcing steel grades with slight changes to the applicable equations. In 2010, the American Concrete Institute (ACI) published the ITG-6R-10 *"Design Guide for the Use of ASTM A1035/A1035M Grade 100 Steel Bars for Structural Concrete,"* which guides engineers to safely design structures using ASTM A1035/A1035M up to yield strength of 100 ksi. The ACI ITG-6R-10 slightly modified the equations in ACI 408R-03 *"Bond and Development of Straight Reinforcing Bars in Tension"* for both confined and unconfined ASTM A1035/A1035M Grade 100 rebar.

The NYC Buildings Bulletin 2015-036 specifies that the development length and lap splice length shall be determined in accordance with ACI 318 Chapter 12 as modified by ICC-ES AC429 sections 4.2.16 and 4.2.17, and ACI ITG 6R-10 section 10.2. Yield stress up to 140 ksi shall be used for calculations for development length of all splices and hooks.

The modified equations for the development length per ACI ITG-6R-10 are shown below:

$$l_d = \frac{\left(\dfrac{f_y}{f_c'^{1/4}} - \phi 2400\omega\right)\alpha\beta_c\lambda}{\phi 76.3\left(\dfrac{c_b\omega + K_{tr}}{d_b}\right)} d_b \quad \text{(in.)}$$

**ACI ITG-6 Equation (10-1)**

$$\left(\frac{c_b\omega + K_{tr}}{d_b}\right) \leq 4.0$$

**ACI ITG-6 Equation (10-5)**

**Where:**

$\ell_d$ = development length (also splice length), (inches)
$f_y$ = yield strength of bar (psi)
$f'c$ = specified concrete compressive strength (psi)
$\phi$ = strength reduction factor (0.80)
$\omega$ = factor reflecting benefit of large cover/spacing perpendicular to controlling cover/spacing ≤ 1.25
$\alpha$ = bar location factor (1.3 for top reinforcement and 1.0 for all other locations)
$\beta c$ = coating factor (1.5 for coated bars and 1.0 for uncoated bars)
$\lambda$ = lightweight aggregate factor (1.3 for lightweight aggregate and 1.0 for normal weight aggregate)
$d_b$ = diameter of bar (inches)
$c_b$ = spacing or cover dimension for spliced reinforcing bar
$K_{tr}$ = transverse reinforcement index

The table below shows the calculated development length of ASTM A1035/A1035M steel reinforcing bars based on the formula above for bars #3 through #11 and a range of concrete compressive strengths (3,000 psi to 12,000 psi) pursuant to NYC Building Bulletin 2015-036.

## Development Length* (inches)

| | Concrete Compressive Strength (psi) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Bar Size** | **3,000** | **4,000** | **5,000** | **6,000** | **7,000** | **8,000** | **9,000** | **10,000** | **11,000** | **12,000** |
| 3 | 26.1 | 24.1 | 22.6 | 21.5 | 20.6 | 19.8 | 19.1 | 18.6 | 18.0 | 17.6 |
| 4 | 34.8 | 32.1 | 30.2 | 28.6 | 27.4 | 26.4 | 25.5 | 24.7 | 24.1 | 23.5 |
| 5 | 43.5 | 40.1 | 37.7 | 35.8 | 34.3 | 33.0 | 31.9 | 30.9 | 30.1 | 29.3 |
| 6 | 52.2 | 48.2 | 45.2 | 43.0 | 41.1 | 39.6 | 38.3 | 37.1 | 36.1 | 35.2 |
| 7 | 62.0 | 57.2 | 53.7 | 51.0 | 48.8 | 47.0 | 45.4 | 44.1 | 42.9 | 41.8 |
| 8 | 79.6 | 73.4 | 68.9 | 65.5 | 62.7 | 60.3 | 58.3 | 56.5 | 55.0 | 53.6 |
| 9 | 99.4 | 91.7 | 86.1 | 81.8 | 78.3 | 75.4 | 72.8 | 70.7 | 68.7 | 67.0 |
| 10 | 123.6 | 114.0 | 107.1 | 101.7 | 97.3 | 93.7 | 90.5 | 87.8 | 85.4 | 83.3 |
| 11 | 149.4 | 137.9 | 129.5 | 123.0 | 117.7 | 113.3 | 109.5 | 106.2 | 103.3 | 100.7 |

**Where:**

fy = 140,000 psi
f'c = 3,000 to 12,000 psi
$\phi$ = 0.80

$\alpha$ = 1.0
$\beta c$ = 1.0
$\lambda$ = 1.0

$c$ = 2 inches
$\omega$ = 1.0
$K_{tr}$ = 1.0 (for simplification)

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