



BEKAERT CORPORATION
 (parent company: NV Bekaert SA)
 1395 South Marietta Parkway
 Building 500, Suite 100
 Marietta, Georgia 30067
www.bekaert.com

CCL
 8296 Sherwick Court
 Jessup, MD 20794
www.cclint.com

**SIGMASLAB® - DRAMIX® STEEL FIBERS
 AND CCL POST-TENSIONING
 MATERIALS IN CONCRETE SLAB
 SYSTEMS**

CSI Sections:

- 03 20 00 – Concrete Reinforcement
- 03 23 00 – Stressed Tendon Reinforcing
- 03 24 00 – Fibrous Reinforcing
- 03 30 00 – Cast-in-Place Concrete
- 03 31 00 – Structural Concrete
- 03 38 00 – Post-Tensioned Concrete
- 03 70 00 – Mass Concrete

1.0 RECOGNITION

SigmaSlab®, recognized in this report, has been evaluated for use as an alternative to post-tensioned slabs conforming to the design requirements of ACI 318 or ACI 360R. The structural properties were evaluated for compliance with the following codes:

- 2018, 2015, and 2009 International Building Code® (IBC)
- 2018 and 2015 International Residential Code® (IRC)
- 2019 California Building Code (CBC) – Attached Supplement
- 2019 California Residential Code (CRC) – Attached Supplement
- 2020 Florida Building Code, Building (FBC, Building) – Attached Supplement
- 2020 Florida Building Code, Residential (FBC, Residential) – Attached Supplement
- 2022 and 2014 New York City Building Code (NYCBC) – Attached Supplement

2.0 LIMITATIONS

Use of SigmaSlab® recognized in this report is subject to the following limitations:

2.1 The scope of the report is limited to the following specific Dramix® fiber models: 4D 55/60BG, 4D 65/35BG,

4D 65/60BG, 4D 80/60BG, 5D 65/60BG, and 5D 65/60GG. UES ER-465 provides additional information for Dramix®.

2.2 Design and construction of SigmaSlab® shall be in accordance with the requirements of Section 3.0 of this report and the codes and standards referenced therein.

2.3 The use of SigmaSlab® in Seismic Force Resisting Systems shall be considered in accordance with Section A1 of Annex A of this report.

2.4 Use is limited to normalweight concrete only. Lightweight concrete is not permitted to be used in SigmaSlab®.

2.5 Use of SigmaSlab® shall be approved by a registered design professional.

2.6 When Dramix® steel fibers are added at the ready-mix plant and/or at the job site, a batch ticket, signed by a ready-mix and/or a job site representative, shall be available to the building official upon request. The delivery ticket shall include, in addition to the items noted in ASTM C94, the type and amount of Dramix® steel fibers added to the concrete mix. Other requirements relative to fiber inclusion into the concrete matrix and the related quality assurance provisions shall be as stipulated by Section 3.0 of this report.

2.7 Fire-resistance rating properties of Dramix® steel fibers are beyond the scope of this report except as provided by this section. The steel fibers are permitted to be used as a component of a fire-resistance-rated assembly in accordance with IBC Section 703.2, based on testing in accordance with ASTM E119 or UL 263. Alternative methods in IBC Section 703.3 are also permitted. Fire resistance based on testing in accordance with ASTM E119 or UL 263 may be established when the registered design professional specifies, and then the building official approves a fire-resistance-rated assembly, listing the specific Dramix® steel fiber models, from the Underwriters Laboratories Online Certifications Directory. All existing fire-resistance design and detailing requirements of the applicable building code shall be provided in all SigmaSlab® systems.

2.8 CCL Post-tensioning system used in SigmaSlab® shall include all bonded and/or unbonded components related to post-tensioning tendons from anchor to anchor as well as stressing and grouting equipment.

2.9 Dramix® fibers are produced by NV Bekaert SA at locations as noted in IAPMO UES ER-465. CCL Post-Tensioning systems are produced by CCL in Jessup, Maryland, or the locations noted in the applicable European Technical Approval (ETA).

The product described in this Uniform Evaluation Service (UES) Report has been evaluated as an alternative material, design or method of construction in order to satisfy and comply with the intent of the provision of the code, as noted in this report, and for at least equivalence to that prescribed in the code in quality, strength, effectiveness, fire resistance, durability and safety, as applicable, in accordance with IBC Section 104.11. This document shall only be reproduced in its entirety.





3.0 PRODUCT USE

3.1 General: Dramix® fiber models enumerated in Section 2.0 of this report are used as an alternative to the conventional reinforcement, either as a partial or full replacement thereof, subject to the stated limitations. SigmaSlab® is a post-tensioned steel fiber reinforced concrete (FRC) slab that combines CCL post-tensioning systems with Bekaert's Dramix® steel fibers. SigmaSlab® has been evaluated for use as elevated (structural) concrete slabs and concrete slabs supported directly on the ground and may be used as an alternative to post-tensioned slab systems designed in accordance with Annex A of this report and either ACI 318 or ACI 360R. In addition to post-tensioning, SigmaSlab® may be reinforced with Dramix® only or Dramix® in combination with mild (non-prestressed) reinforcement. The post-tensioning system may be bonded or unbonded.

3.2 Design:

3.2.1 Design Scope: The design scope shall be as defined and limited by Section A1 of Annex A of this report.

3.2.2 Nominal Material Properties: Nominal material properties used in the design for strength and serviceability shall be as defined in Section A3.1 of Annex A of this report.

3.2.3 Determination of Required Strength, and Member and Section Nominal and Design Strengths: Required, nominal, and design strengths of members and sections, as applicable, shall be determined in accordance with Section A4 of Annex A of this report.

3.2.4 SigmaSlab® Requirements: SigmaSlab® design requirements shall be in accordance with Section A5 of Annex A of this report.

3.2.5 Serviceability: Structural systems' serviceability shall be considered in accordance with Section A6 of Annex A of this report.

3.2.6 Durability of Members and Systems: Structural and non-structural system durability shall be considered in accordance with Section A8 of Annex A of this report.

3.3 Installation: The manufacturer's published installation instructions for Dramix® steel fibers, CCL's post-tensioning systems, and this report shall be strictly adhered to at all times on the job site during installation. If there are any conflicts between this report and the manufacturer's published installation instructions, the more restrictive shall govern. Concrete with steel fibers shall comply with ASTM C1116, Type I. Dramix® fibers may be added to the concrete at the ready-mix plant or the job site.

3.4 Quality Assurance: The manufacturer's published quality assurance specifications for Dramix®, CCL post-tensioning systems, and Section A7 of Annex A of this report shall be adhered to.

4.0 PRODUCT DESCRIPTION

4.1 SigmaSlab®: SigmaSlab® is a post-tensioned concrete slab system consisting of Dramix® fibers with or without conventional bonded reinforcement and CCL's post-tensioning tendons and systems.

4.2 Dramix®: UES ER-465, held by Bekaert Corporation contains information on approved fiber types and descriptions. Dramix® (IMIX-XS) fibers are cold-drawn, hooked wire fibers with end anchors complying with the requirements of ASTM A820, Type I. The fibers are delivered either in loose form or as glued clips. Dramix® 4D fibers are manufactured from non-alloy steel rods complying with ISO 16120-2, Grades C15D-C20D. Dramix® 5D fibers are manufactured from high-carbon steel rods complying with ISO 16120-2, Grades C78D-C86D. Dimensions for each fiber model are provided in Table 1 of this report.

TABLE 1 – Dramix® Steel Fiber Dimensions

Fiber Model	Length (mm)	Diameter (mm)
4D 55/60BG	61	1.05
4D 65/35BG	36	0.55
4D 65/60BG	61	0.90
4D 80/60BG	61	0.75
5D 65/60BG, GG	62	0.90

Note: 1 mm = 0.039 inch

Galvanized Dramix® steel fibers contain a minimum 0.098 oz/ft² (30 g/m²) zinc coating. In a Dramix® steel fiber model designation TD UV/WX YZ, Y= G when the wire is galvanized, and Y=B when the wire is bright. Z= G when the fibers are delivered in glued form, and Z= L when the fibers are loose. The letter T is a designator reflecting the number of straight wire segments in the end-anchor configuration. UV designation is indicative of the aspect ratio of the product based on the length of the product. WX is indicative of the length of the product.

Dramix® fibers are packaged in 44.1-pound (20 kg) non-water-soluble bags and 2,450-pound (1100 kg) bags. The glued Dramix® steel fibers are adhered into clips and separate into individual elements when added to the concrete mix.

4.3 CCL Post-Tensioning Systems: Post-tensioning tendon components include anchors and accessories, bare strands, ducts for bonded applications, and sheathed strands for unbonded applications. The post-tensioning tendons shall be manufactured at CCL USA's Post-Tensioning Institute (PTI) certified plant in Jessup, Maryland, and shall comply with ACI 318-14 or -19 Section 20.3, or ACI 318-11 Section 18.14, and with the Post-Tensioning Institute Certification requirements in PTI-CRT20 G1-1120. Alternatively, the post-tensioning system shall be manufactured according to CCL's ETA-approved post-tensioning systems XF (ETA-10/0107), XM (ETA-07/0035), and XU2 (ETA-19/0733), complying with the requirements of EAD 160004-00-0301,



Post-Tensioning Kits for Prestressing of Structures, for bonded and unbonded applications.

5.0 COMPONENT IDENTIFICATION

Dramix® fibers are identified in accordance with IAPMO UES ER-465 held by Bekaert Corporation. The post-tensioning systems are identified in accordance with the corresponding European Technical Approval (ETA) or CCL USA's PTI plant certification.

6.0 SUBSTANTIATING DATA

6.1 Manufacturer's descriptive literature and installation instructions. Test results are from laboratories in compliance with ISO/IEC 17025.

6.2 Data in accordance with the Evaluation Criteria for Anchored Steel Fibers in Concrete (IAPMO UES EC 026), adopted June 2023, including testing of concrete slabs with combinations of post-tensioning systems and steel fibers.

6.3 Dimensional and mechanical property test data in accordance with ASTM A820.

6.4 Flexural performance testing in accordance with ASTM C1609 and EN14651.

6.5 Data in accordance with the Acceptance Criteria for Steel Fibers in Concrete (ICC-ES AC208), approved October 2005, editorially revised March 2023.

6.6 References as listed in Section A2.1 of Annex A of this report.

6.7 Post-tensioning system strands and anchors data in accordance with ACI 318 and ACI 423.7

7.0 STATEMENT OF RECOGNITION

This evaluation report describes the results of research completed by IAPMO Uniform Evaluation Service on SigmaSlab® to assess conformance to the codes shown in Section 1.0 of this report and documents the product's certification. Dramix® is manufactured at locations noted in Section 2.10 of IAPMO UES ER-465 of this report under a quality control program with periodic inspection under the supervision of IAPMO UES. CCL's components are not inspected by IAPMO UES but are recognized as constituent components of SigmaSlab®.

For additional information about this evaluation report please visit www.uniform-es.org or email at info@uniform-es.org



FLORIDA SUPPLEMENT

SIGMASLAB® - DRAMIX® STEEL FIBERS AND CCL POST-TENSIONING MATERIALS IN CONCRETE SLAB SYSTEMS

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- 03 70 00 – Mass Concrete

1.0 RECOGNITION

SigmaSlab® as evaluated and represented in IAPMO UES Evaluation Report ER-664 and with changes as noted in this supplement is a satisfactory alternative for use in buildings built under the following codes:

- 2020 Florida Building Code, Building
- 2020 Florida Building Code, Residential

2.0 LIMITATIONS

Use of SigmaSlab® recognized in this report is subject to the following limitations:

2.1 The design, installation, limitations, and identification of the SigmaSlab® shall be in accordance with the 2018 International Building Code or the 2018 International Residential Code, as applicable, as noted in ER-664, except as specifically described in this supplement.

2.2 Verification shall be provided that a quality assurance agency audits the manufacturer's quality assurance program and audits the production quality of products, in accordance with Section (5)(d) of Florida Rule 61G20-3.008. The quality assurance agency shall be approved by the Commission (or the building official when the report holder does not possess an approval from the Commission).

2.3 The requirements for High-velocity Hurricane Zones (HVHZ) in the Florida Building Code, Building and the Florida Building Code, Residential are beyond the scope of this review.

2.4 This supplement expires concurrently with ER-664.

For additional information about this evaluation report please visit www.uniform-es.org or email at info@uniform-es.org



CALIFORNIA SUPPLEMENT

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CSI Sections:

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- 03 70 00 – Mass Concrete

1.0 RECOGNITION

SigmaSlab® as evaluated and represented in IAPMO UES Evaluation Report ER-664 and with changes as noted in this supplement is a satisfactory alternative for use in buildings built under the following codes:

- 2019 California Building Code (CBC)
- 2019 California Residential Code (CRC)

2.0 LIMITATIONS

Use of SigmaSlab® recognized in this report is subject to the following limitations:

2.1 The design, installation, limitations, and identification of the SigmaSlab® shall be in accordance with the 2018 International Building Code or the 2018 International Residential Code, as applicable, as noted in ER-664, except as specifically described in this supplement.

2.2 The use of steel fiber reinforcement shall not be permitted in structures regulated by the Division of the State Architect-Structural Safety (DSA-SS), and in applications regulated by the Office of Statewide Health Planning and Development (OSHDP) in accordance with Sections 1903.7, 1909.2.2, and 1903A.7 of the CBC.

2.3 This supplement expires concurrently with ER-664.

For additional information about this evaluation report please visit www.uniform-es.org or email at info@uniform-es.org



CITY OF NEW YORK SUPPLEMENT

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1.0 RECOGNITION

SigmaSlab® as evaluated and represented in IAPMO UES Evaluation Report ER-664 and with changes as noted in this supplement is a satisfactory alternative for use in buildings built under the following codes (and regulations):

- 2022 and 2014 New York City Building Code (NYCBC)

2.0 LIMITATIONS

Use of SigmaSlab® recognized in this report is subject to the following limitations:

2.1 The design, installation, limitations, and identification of the SigmaSlab® under the 2022 NYCBC shall be in accordance with the 2015 International Building Code or, under the 2014 NYCBC, shall be in accordance with the 2009 International Building Code, as applicable, as noted in ER-664, except as specifically described in this supplement.

2.2 The performance of the mix design shall be confirmed when using steel fibers in accordance with Section 1905.3.5.2 of the NYCBC.

2.3 Unless used in applications complying with the provisions of ACI 318-14 Section 9.6.31 or ACI 318-11 Sec. 11.4.6.1(f), steel fibers used in beams need not comply with the requirements of Section 1905.6.6 of the NYCBC, except that special inspection requirements shall apply.

2.4 This supplement expires concurrently with ER-664.

For additional information about this evaluation report please visit www.uniform-es.org or email at info@uniform-es.org