LEGACY REPORT

ER-5645

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Legacy report on the 1997 *Uniform Building Code*™, the 2000 *International Building Code*® and the 2000 *International Residential Code*®

DIVISION: 03—CONCRETE
Section: 03210—Reinforcing Steel

NMB SPLICE-SLEEVES

SPLICE SLEEVE NORTH AMERICA, INC.
192 TECHNOLOGY DRIVE, SUITE J
IRVINE, CALIFORNIA 92618-2409

1.0 SUBJECT

NMB Splice-Sleeves®.

2.0 DESCRIPTION

2.1 General:

The NMB Splice-Sleeves are used as mechanical splices of deformed rebar in concrete construction. The three types of sleeves available are Type U-X, Type U and Type SNX. The sleeves are used with SS Mortar as described in Section 2.2.4.

2.2 Materials:

2.2.1 NMB Splice-Sleeve Type U-X Sleeves: The Type U-X NMB Splice-Sleeves consist of straight and half-tapered steel cylinders, with four to seven internal annular ridges spaced between 0.591 inch (15 mm) and 1.181 inches (30 mm) on center, depending on sleeve model. The midsection of the interior of the sleeve is provided with a rebar stop that establishes the proper embedment of the reinforcing bars. As an optional feature, the sleeves are available with a set screw located on the side of the narrow end of the sleeve. The set screw temporarily attaches the sleeve to the rebar inserted in the narrow end of the sleeve prior to the installation of the grout. The sleeve material complies with ASTM A 536 Grade 85-60-06 [minimum yield and tensile strengths of 60,000 and 85,000 psi (413 and 586 MPa), respectively] for all sleeve sizes greater than No. 6, and Grade 64-41-10 [minimum yield and tensile strengths of 41,000 and 64,000 psi (282 and 441 MPa), respectively] for sleeve sizes No. 6 and below. The Type U-X sleeves are furnished in sizes set forth in Table 1. The Type U-X sleeves comply as tension or compression splices for deformed reinforcing bars as specified in Section 1912.14.3.4 of the 1997 *Uniform Building Code*™ (UBC) and Section 21.2.6.1 of ACI 318-99 [ACI 318-99 is referenced in 2000 *International Building Code*® (IBC) Section 1901 and 2000 *International Residential Code*® (IRC) Section R612]. The sleeves also comply with the Type 2 mechanical splice requirements of Section 1921.2.6.1.2 of the UBC and Section 21.2.6.1 of ACI 318-99. For all sizes of the Type U-X sleeves, except for the 14 U-X sleeve, the sleeves are used to splice reinforcement bars of one size as specified in Table 1. The 14 U-X sleeves are recognized to splice No. 14 reinforcing bars and for use as a transition splice to connect a No. 14 reinforcing bar to a No. 9 reinforcing bar, provided both reinforcing bars are inserted into the sleeve with the embedment specified in Table 1 for No. 14 reinforcing bar.

2.2.2 NMB Splice-Sleeve Type U Sleeves: The Type U NMB Splice-Sleeves consist of double-tapered frustrum-shaped steel cylinders with annular grooves in the inner wall spaced 0.787 inch (20.0 mm) throughout the sleeves. The material complies with ASTM A 536 Grade 85-60-06, with minimum yield and tensile strengths of 60,000 and 85,000 pounds per square inch (413 and 586 MPa), respectively. The sleeves are furnished in sizes set forth in Table 2. The Type U sleeve complies as a tension or compression splice for deformed reinforcing bars as specified in Section 1912.14.3.4 of the UBC and Section 21.2.6.1 of ACI 318-99. The sleeves also comply with the Type 2 mechanical splice requirements of Section 1921.2.6.1.2 of the UBC and Section 21.2.6.1 of ACI 318-99.

2.2.3 NMB Splice-Sleeve Type SNX Sleeves: The Type SNX NMB Splice-Sleeves consist of straight steel cylinders, with four to seven internal ridges spaced between 0.591 inch (15 mm) and 1.181 inches (30 mm) on center, depending on sleeve model. The midsection of the interior of the sleeve is provided with a rebar stop which establishes the proper distance of embedment of the reinforcing bars. As an optional feature, the sleeves are available with a set screw located on the side of the narrow end of the sleeve. The set screw is used to provide temporary attachment of the sleeve to the rebar inserted in the narrow end of the sleeve prior to the installation of the grout. The sleeve material complies with ASTM A 536 Grade 85-60-06. The type SNX sleeves are furnished in sizes set forth in Table 3. The Type SNX sleeve complies as a tension or compression splice for deformed reinforcing bars as specified in Section 1912.14.3.4 of the UBC and Section 21.2.6.1 of ACI 318-99. The sleeves also comply with the Type 2 mechanical splice requirements of Section 1921.2.6.1.2 of the UBC and Section 21.2.6.1 of ACI 318-99.

2.2.4 SS Mortar: SS Mortar is a nonshrink, high-strength, metallic-reinforced grout manufactured by Degussa Construction Systems America, packaged in 55-pound (25 kg) bags. The material has a shelf life of 18 months when stored in a cool dry environment.

2.2.5 Reinforcing Steel Bars: The reinforcing steel bars must be deformed bars complying with ASTM A 615 Grade 60 or ASTM A 706.

2.3 Installation:

All reinforcement must be clean and free from loose rust, oils, dust and other foreign material. All excess water and foreign matter must be removed from the sleeve. All laitance and loose or foreign materials must be removed from concrete surfaces to be joined, and surfaces kept moist.

Sleeves must be prepared and installed in accordance with the recommendations noted in the "NMB Splice Sleeve System User's Manual," dated February 1993. Sleeves must be prepared by:

1. Installing the rubber plug (RP) on the small-diameter end of the sleeve.
2. Securely attaching PVC grout tubes according to the instructions for PG applications.
3. Sealing the grout ports (PRE) or PVC grout tubes (PG) with plastic seals furnished by the manufacturer.

For Type U sleeves, the prepared sleeve must be installed on the first rebar so that the minimum specified embedment length is assured. For Type U-X and SNX sleeves, the prepared sleeve must be installed on the first rebar so that the bar end is in contact with the rebar stop inside the sleeve, to assure the specified embedment length. The embedment length of connected bars shall meet the minimum embedments as shown in Tables 1 through 3.

Reinforcement must be embedded to approximately half the depth of the sleeve, with a maximum gap between the reinforcement of 1.0 times the diameter for the Type U splices. The adjoining bars must not slope more than the angle whose tangent is equal to $L/[2(D-d)]$, where L is the sleeve length, d is the bar diameter and D is the inside diameter of the wider end of the sleeve.

Sleeves must be securely fastened to the concrete forms by means of the sleeve setter (STR). After concrete has been poured and forms removed, the sleeve must be examined to see that there has been no leakage of concrete into the sleeves and grout tubes. Any such material must be removed.

The sleeves must be grouted with SS Mortar, which is mixed with clean water according to the grout manufacturer's recommendations. Grout must be proportioned so that the stable splice strength can be attained by achieving a minimum strength of not less than 11,000 psi (75.8 MPa) in 28 days as determined by testing specimens made according to the specified test method. Grout must be poured or pumped into the sleeves, depending upon the location of the sleeves. For pre-grout (PRE) installation, the grout must be poured into the sleeves and rodded or vibrated to consolidate it. For post-grout (PG) installations, grout must be pumped into the inlet (larger) grout tube until it flows freely from the outlet (smaller) tube. Immediately after grout outflow is observed, and before the pump nozzle is removed, a rubber (only) stopper must be inserted into the outlet grout tube. Immediately upon removal of the nozzle from the inlet grout tube, a rubber stopper must be inserted into the inlet grout tube in such a manner as to prevent leakage of grout from the sleeve. All spaces within the sleeve must be fully penetrated with the approved grout, and excess grout must be removed.

All spliced joints must be adequately braced and supported in order to prevent movement until the grout gains sufficient strength to permit removal of supports. The engineer of record may permit removal of braces under conventional erection procedures after the grout has attained a minimum compressive strength of 2845 psi (19 602 kPa) as determined by testing of grout specimens cured under jobsite conditions. Under anticipated special conditions of loading, the engineer may require greater strength in the connections as necessary to resist imposed loads, and must specify that higher grout strength be attained prior to removal of supports. Grout strength must be determined by means of compression testing 2-inch (51 mm) cube specimens in accordance with ASTM C 109, C 942 and the recommendations of both the grout manufacturer and Splice Sleeve North America, Inc.

In cold weather, in order to protect the grout from freezing, and to accelerate strength gain, heat must be supplied internally or externally, by methods meeting the requirements of ACI 318, Section 5.12, or UBC Section 1905.12. After grouting, the temperature of the splices must be maintained above 40˚F (4.4˚C) by an approved method of heat addition until the grout has attained a minimum compressive strength of 1,500 psi (10.3 MPa) as determined by the testing of 2-inch (51 mm) cube specimens cured under jobsite conditions.

In the event the reinforcement bars do not meet embedment length minimums or the 28-day strength test of the grout is less than 11,000 psi (75.8 MPa) as determined by the testing of 2-inch (51 mm) cube specimens, the engineer of record, with the approval of the building official, must determine the appropriate corrective measures to be taken. Appropriate corrective measures, at the discretion of the engineer, include structural analysis of available test data, preparation and testing of additional samples, extension of the bars, removal and replacement of the sleeves, or any combination of the above.

2.4 Special Inspection:

Special inspection is required in accordance with UBC Section 1701 or IBC Section 1704, as applicable. The inspector's duties include inspecting grade and size of reinforcing bars; coupler identification; coupler location; rebar embedment into couplers; SS Mortar identification and mixing procedure; preparation of SS Mortar compression test specimens; and grouting of couplers.

2.5 Identification:

Each NMB Splice Sleeve is marked with the company logo (NMB), the sleeve size, the evaluation report number (ER-5645), the designation of Type 2, and a production control number. Each container of sleeves is marked with the Splice Sleeve North America, Inc., name and address, NMB SPLICE-SLEEVE® as the logo, sleeve size, evaluation report number (ER-5645), and the designation of Type 2.

Each bag of SS Mortar is marked with the Master Builders, Inc., name and address, product designation, evaluation report number (ER-5645), mixing instructions and expiration date.

3.0 EVIDENCE SUBMITTED

Data in accordance with the Acceptance Criteria for Mechanical Connectors for Steel Bar Reinforcement (AC133), dated April 2002; and reports of freeze-thaw and elevated temperature tests.

4.0 FINDINGS

That the NMB Splice-Sleeves described in this report comply with the 1997 *Uniform Building Code*™, the 2000 *International Building Code*® and the 2000 *International Residential Code*®, subject to the following conditions:

4.1 The NMB Splice-Sleeves and grout are manufactured, identified and installed in accordance with the applicable code, the manufacturer's instructions and this report.

4.2 Special inspection is provided in accordance with Section 2.4 of this report.

4.3 Minimum concrete cover is in accordance with the applicable code and is measured from the outer surface of the NMB Splice-Sleeve for both fire-resistance-rated and nonfire-resistance-rated construction.

This report is subject to re-examination in two years.

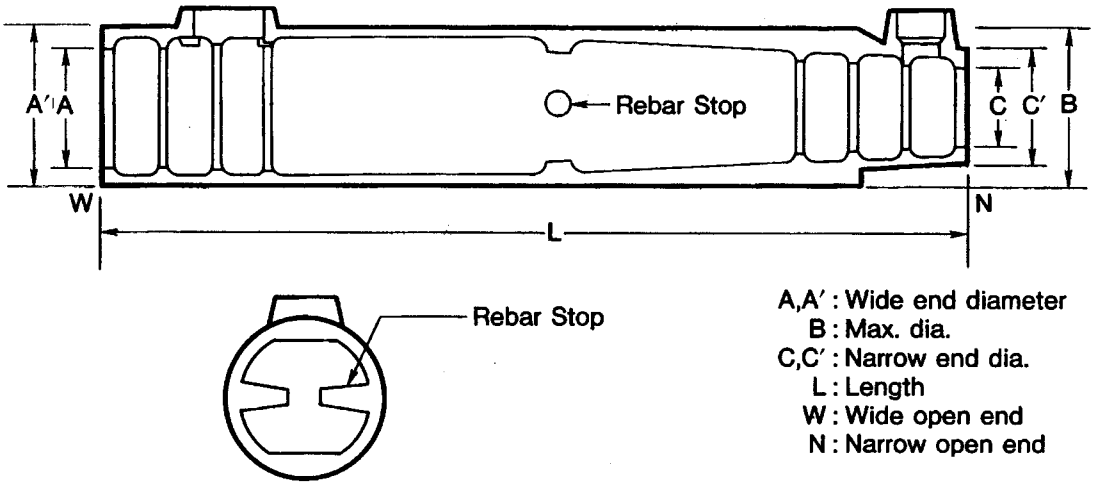

TABLE 1—DIMENSIONS OF TYPE U-X NMB SPLICE-SLEEVES

DIMENSIONS OF NMB SPLICE-SLEEVES											REQUIRED REBAR EMBEDMENT LENGTH			
Sleeve No.	Bar Diameter	Bar Size		Sleeve Length (L) (inches)	Narrow End Diameter (inches)		Maximum Diameter (B) (inches)	Wide End Diameter (inches)			Factory Dowel (E1) (inches)		Field Dowel (E2) (inches)	
		ASTM	JIS		I.D. (C)	O.D. (C′)		I.D. (A)	Total Tolerance[1]	O.D. (A′)	Minimum	Maximum	Minimum	Maximum
5U-X	0.625	#5	D16	9.65	0.87	1.50	1.81	1.26	0.63	1.89	4.13	4.33	4.13	4.92
6U-X	0.750	#6	D19	11.22	1.02	1.65	1.97	1.42	0.67	2.05	4.92	5.12	4.92	5.71
7U-X	0.875	#7	D22	12.80	1.14	1.77	2.28	1.73	0.86	2.36	5.71	5.91	5.71	6.50
8U-X	1.000	#8	D25	14.57	1.30	1.93	2.48	1.89	0.89	2.52	6.50	6.69	6.50	7.48
9U-X	1.128	#9	D29	16.34	1.42	2.06	2.60	2.01	0.89	2.67	7.40	7.56	7.40	8.35
10U-X	1.270	#10	D32	17.91	1.57	2.28	2.80	2.16	0.89	2.87	8.19	8.35	8.19	9.13
11U-X	1.410	#11	D35	19.49	1.73	2.40	3.03	2.32	0.91	3.03	8.98	9.13	8.98	9.92
14U-X	1.693	#14	D41	24.41	2.01	2.80	3.46	2.60	0.91	3.46	11.42	11.61	11.42	12.40

For **SI:** 1 inch = 25.4 mm.
[1]After bar is inserted into sleeve.

TABLE 2—DIMENSIONS OF TYPE U NMB SPLICE-SLEEVES

DIMENSIONS OF NBM SPLICE-SLEEVES											REQUIRED REBAR EMBEDMENT LENGTH			
Sleeve No.	Bar Diameter	Bar Size		Sleeve Length (L) (inches)	Narrow End Diameter (inches)		Maximum Diameter (B) (inches)	Wide End Diameter (inches)			Factory Dowel (E1) (inches)		Field Dowel (E2) (inches)	
		ASTM	JIS		I.D. (C)	O.D. (C)		I.D. (A)	Total Tolerance[1]	O.D. (A′)	Minimum	Maximum	Minimum	Maximum
18U[2]	2.257	#18	—	36.22	2.68	3.66	4.72	3.27	1.01	4.25	17.00	18.11	17.00	18.11

For **SI:** 1 inch = 25.4 mm.
[1]After bar is inserted into sleeve.
[2]No rebar stop is provided.

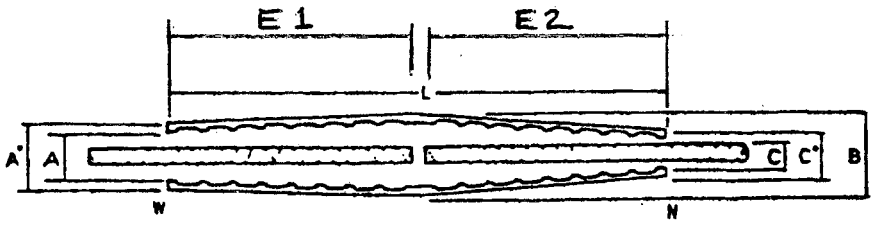

TABLE 3—DIMENSIONS OF TYPE SNX NMB SPLICE SLEEVES

DIMENSIONS OF NMB SPLICE-SLEEVE											REQUIRED REBAR EMBEDMENT LENGTH			
Sleeve No.	Bar Diameter	Bar Size		Sleeve Length (L) (inches)	Narrow End Diameter (inches)		Maximum Diameter (B) (inches)	Wide End Diameter (inches)			Factory Dowel (E1) (inches)		Field Dowel (E2) (inches)	
		ASTM	JIS		I.D. (C)	O.D. (C')		I.D. (A)	Total Tolerance[1]	O.D. (A')	Minimum	Maximum	Minimum	Maximum
11SNX[2]	1.410	#11	D35	19.09	1.69	2.52	3.03	2.32	0.91	3.03	8.86	9.25	8.27	9.45

For **SI:** 1 inch = 25.4 mm.

[1]After bar is inserted into sleeve.

[2]Set Screw Sleeve is available as an option.