

## **Design Recommendations: “Ultimate Splice”, Hoops and Spirals**

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### General

The following 2 pages summarize and update issues presented in Memos to Designers (MTD) 20-9. These updates will be incorporated into a revised MTD 20-9 at a later date. Please review the current MTD 20-9 for additional information.

1. In general, “Ultimate Splice” requirements apply only to structural elements that are determined to be “Seismic Critical” (SC). Splicing requirements per Standard Specifications apply to elements that are not seismic critical with the exceptions stated in MTD 20-9 and/or SDC (eg. “Service Splice”).
2. The Design Engineer shall identify all SC elements on a bridge (see MTD 20-9 for seismic critical elements) at the design phase.
3. In SC elements, within the plastic hinge zone, no splicing is permitted in the main/longitudinal rebars. Show this zone on Plans.
4. Outside the plastic hinge zone, all main/longitudinal rebars shall have “Ultimate Splice” - if splicing is required. In such cases, show this on Plans (see MTD 20-9). Typically, no splicing in a longitudinal rebar is required if its total length (including hooks) is less than 18 meters.
5. All transverse reinforcement in SC elements shall, in general, have “Ultimate Splice” specified. This should be shown on Plans. Since “Ultimate Splice” in spirals is still under development, SC elements should generally incorporate hoops with the exceptions stated below.

### Hoops and Spirals:

1. In general, “hoops” imply “hoops” with “Ultimate Splice”.
2. In SC elements, when the cage diameter exceeds 360mm, hoops (with “Ultimate Splice”) should be used.
3. #16M should be the smallest rebar size used in hoops until further notice.
4. Spirals should be used when the cage diameter in a SC element is smaller than 360 mm. The performance of hoops fabricated to diameters smaller than 360 mm is currently being evaluated.
5. Where spirals are used in SC elements, special hooks (see MTD 20-9) should be used for intermediate splices (both for terminating one spiral and starting another

spiral). This detail should be shown on Plans. When special hooks are provided at intermediate locations, they may interfere with concrete placement. Therefore, every effort must be made to minimize the number of such splices as well as minimize their interference with concrete placement.

6. Where spirals are used in SC elements, their termination (e.g.: at the soffit) should follow the guidelines presented in MTD 20-9.

### Examples

The following Table illustrates some of the common structural elements and the type of splicing that is generally adopted in each case. Please note that this is a general guideline, but the Design Engineer should use proper engineering judgement specific to each case. In cases of exceptions, the issues should be discussed with your branch seismic specialist and/or the Reinforce Concrete specialist.

No.	Element Name (dim. in mm)	Element type	Transverse Reinf. type	Splice type and/or comments
1	Bridge columns with cage dia. $\geq 360$	SC	Hoops	Longit. rebars: "Ultimate Splice" outside no-splice zone (NSZ) Transverse rebars: Hoops
2	Bridge columns with cage dia. $< 360$	SC	Spirals	Longit. rebars: "Ultimate Splice" outside NSZ. Transverse rebars: Spirals with special hooks per MTD 20-9 for intermediate splicing.
3	Piles with pile extensions	SC	Similar requirements as in (1) or (2)	
4	Prismatic or enlarged shaft ( $> 360$ ) supporting a column	See MTD 20-9	Hoops	Longit. Rebars: "Ultimate Splice" outside NSZ. Transverse rebars: Hoops
5	CIDH Piles – wet condition	-	When these elements are deemed to be SC, then, for: longitudinal rebars "Ultimate Splice" outside NSZ is required <b>with modified testing requirements</b> . Transverse rebars: Same as (1) or (2).	
6	CIDH piles – normal condition	-	When these elements are deemed to be SC, then same requirements as (1) or (2).	
7	CISS piles	-	When these elements are deemed to be SC, then, for: longitudinal rebars "Ultimate Splice" outside NSZ is required. Modified testing requirements may have to be specified in some cases. Transverse rebars: The Design Engineer is required to evaluate the splice type based on cut-off location for the steel casing, redundancy (single or multiple columns) and capacity requirements.	

Footnotes: 1. SC – Seismic Critical