Steel Reinforcement Institute of Australia

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MECHANICAL SPLICES FOR JOINING REINFORCEMENT

One of the ways that reinforcement can be spliced is by the use of some form of mechanical splice. Two of the common forms of mechanical splice involve the use of a coupler (threaded device for joining reinforcing bars) or coupling sleeve (non-threaded device) in order to transfer axial tension or compression (or both) from one bar to another **Figures 1 and 2.**

Tapered thread

Sleeve extruded over bar end with parallel thread

Parallel thread

Proprietary bar couplers

Figure 1 Examples of couplers

Mechanically bolted

Grouted

Figure 2 Examples of coupling sleeves

Mechanical splices can be used for:

- Reducing reinforcement congestion - particularly in structures where heavy reinforcement will physically not allow the incorporation of lap splices, or heavily reinforced elements such as columns and walls.
- Satisfying design requirements – Clause 25.5.1.1 of ACI 318M-14 does not allow the use of lap splices for bars larger than 36 mm in diameter.
- Improving structural integrity – unlike lap splices, mechanical splices do not rely on the concrete to transfer the stress from one bar to another, in order to achieve their strength. In extreme events such as seismic loading, where the structure in critical regions is anticipated to behave inelastically, normal lap splices tend to loose strength/effectiveness due to de-bonding as the bar begins to yield.
- Improving constructability – couplers anchored in core walls can be used for extending reinforcement into the slab/diaphragm to form an integral joint with collector reinforcement once the jump forms have moved up.
- Repairs/rehabilitation/retrofit work – replacement of corroded reinforcement during repairs to reinforced concrete structures or extension of existing reinforcement in structures during refit works are possible with special mechanical splices.

Clause 13.2.6 of AS 3600 covers mechanical splices between Ductility Class N reinforcing bars. The requirements are simple: they shall not fail prematurely in tension or compression before the reinforcing bars (unless it can be shown that the strength and ductility of the concrete member meets the design requirements), and if the effective slip in the assemblage could exceed 0.1 mm at a tensile stress of 300 MPa, then the effects of this elongation are to be taken into account if control of cracking or vertical deflection are serviceability design criteria.

Clause 25.5.7.1 of ACI 318M-14 requires that all mechanical splices shall develop (in tension or compression as required), at least $1.25f_{sy}$ of the bar. According to the commentary, this limit was set to ensure yielding of the member and avoid brittle failure. Clause 18.2.7.1 of the ACI Standard also classifies mechanical splices into two types: Type 1 and Type 2. Type 1 must achieve a strength of $1.25f_{sy}$, and Type 2, in additional to achieving this strength, must also be capable of developing the specified tensile strength of the spliced bars. For special moment-resisting frames (SMRFs), having a structural ductility factor of 4 (outside the scope of Australian Standards), the ACI Standards only allow Type 2 mechanical splices in certain locations such as within $2D$ of supporting columns or beams, in order to cope with the strain hardening of the reinforcement that occurs when the structure is behaving inelastically under extreme loadings. Hence, mechanical splices conforming to the Type 1 requirements can be used in all locations for the ordinary and intermediate moment-resisting frames used in Australia. This is consistent with Clause 13.2.6 of AS 5100.5, where a minimum ultimate tensile strength of $1.25f_{sy}$ is required.

The ability to join reinforcing bars anywhere within a structure allows reinforcement beam cages to be prefabricated, lifted into position and spliced at column locations, providing more efficiency and economy in assembly of reinforcement. Note that for IMRFs, lap splicing of reinforcement is not recommended

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within 2*D* of any supporting columns or beams (refer to the SRIA's Seismic Guide freely available for download from our web site).

There are a number of proprietary systems available to mechanically splice reinforcing bars in Australia, including both coupler and coupling sleeve systems (both mechanically bolted and grouted), and specific design and detailing parameters for the various systems can be found via the links on our web site to our Associate Member manufacturers of these products. Detailers should consult the manufacturer's websites and examine the details to satisfy themselves on the type and detail they should use and how to specify them. In some cases, mechanical splices are designed specifically for proprietary bars types, or to splice proprietary bars to 'normal' deformed reinforcing bars.

Detailers should also note that the cover to reinforcement equally applies to any mechanical splice, and in Australian Standards there is no reduction in the cover when hot dipped galvanised couplers or reinforcement is used. Where mechanical splices are located in areas such as construction joints and joints between precast walls, and where moisture occurs and durability is of concern, then consideration should be given to the use (as a minimum), of galvanised mechanical splices and bars.

Third party quality assurance in the form of a technical compliance is also recommended for these important connecting elements between reinforcing bars that should already have some form of third party certification of compliance with AS/NZS 4671 Steel reinforcing materials

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INDUSTRY NEWS

AS 3600 Concrete structures

Consideration of public comments occurred in November with publication expected early in 2018.

AS/NZS 4671 Steel reinforcing materials

A project proposal was lodged with Standards Australia in the September round and work is continuing on development to update various sections of the Standard**.**

AS/NZS 1554.3 Structural steel welding – Welding of reinforcing steel

This amended Standard was published in November 2017.

Technical Note TN7

This Technical Note which is intended to reduce the time required to determine the tensile development and lap lengths for reinforcing bars, and includes valuable background information and worked examples is available for free download from the SRIA website.

Quality Issues and Recent Updates to Standards

A presentation covering reinforcement quality issues and recent updates to AS 3600 Concrete structures, AS 3700 Masonry structures, AS 3727.1 Pavements Part 1: Residential, along with an overview of tensile development and lap lengths has been added to our web site for free download (under Resources, then Downloads).

Historical Reinforcement

Our recent CIA Conference Paper and presentation covering the changes to reinforcement and its properties from the 1890s to present day, an area which generates the majority of our technical enquiries, has been added to our website for free download (under Resources, then Conference Papers). The SRIA is also currently working on a new Guide in this area which will be published next year.

The Control of Random Cracking in Concrete Residential Pavements

Our recent CIA Conference Paper and presentation covering changes to AS 3727.1 Pavements Part 1: Residential (which is now a mandatory Standard), looks at how the changes impact on not only random cracking, but controlling the width of random cracks to an aesthetically acceptable limit of 0.3 to 0.4 mm. They are freely available from our web site (under Resources, then Conference Papers).

SEISMIC DESIGN AND DETAILING OF REINFORCED CONCRETE BUILDINGS IN AUSTRALIA

For those interested in learning more about this essential topic, the SRIA has produced the *Guide to Seismic Design and Detailing of Reinforced Concrete Buildings in Australia*. The publication is available as a free download from the SRIA website, or for purchase as a hardcopy for a nominal cost of $37.00 including delivery anywhere within Australia.

A webinar covering this topic, which is based on a successful National Seminar Series with the CIA and AEES, is also available from the CIA website (www.concreteinstitute.com.au)

SRIA REGISTRATION FORM

To keep informed of the most recent industry developments, releases and presentations on steel reinforcement and to maintain your professional development, register now for the SRIA website database. Your details will remain highly confidential and we will ensure your reinforcement knowledge remains up-to-date.

You may register online at **www.sria.com.au/registration.html**

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