CODE

25.4—Development of reinforcement

25.4.1 *General*

25.4.1.1 Calculated tension or compression in reinforcement at each section of a member shall be developed on each side of that section by embedment length; hook, headed deformed bar, mechanical device, or a combination thereof.

25.4.1.2 Hooks and heads shall not be used to develop bars in compression.

25.4.1.3 Development lengths do not require a strength reduction factor ϕ.

25.4.1.4 The values of $\sqrt{f_c'}$ used to calculate development length shall not exceed 8.3 MPa.

25.4.2 *Development of deformed bars and deformed wires in tension*

25.4.2.1 Development length ℓ_d for deformed bars and deformed wires in tension shall be the greater of (a) and (b):

COMMENTARY

R25.4—Development of reinforcement

R25.4.1 *General*

R25.4.1.1 The development length concept is based on the attainable average bond stress over the length of embedment of the reinforcement (ACI Committee 408 1966). Development lengths are required because of the tendency of highly stressed bars to split relatively thin sections of restraining concrete. A single bar embedded in a mass of concrete should not require as great a development length, although a row of bars, even in mass concrete, can create a weakened plane with longitudinal splitting along the plane of the bars.

In application, the development length concept requires minimum lengths or extensions of reinforcement beyond all points of peak stress in the reinforcement. Such peak stresses generally occur at the points of maximum stress and points where reinforcement is bent or terminated. From a point of peak stress in reinforcement, some length of reinforcement or anchorage is necessary to develop the stress. This development length or anchorage is necessary on both sides of such peak stress points. Often, the reinforcement continues for a considerable distance on one side of a critical stress point so that calculations need involve only the other side, for example, the negative moment reinforcement continuing through a support to the middle of the next span. The requirement for a minimum value of K_{tr} along development and splice lengths in 9.7.1.4, 10.7.1.3, 25.4.2.2, and 25.5.1.5 improves ductility.

R25.4.1.2 Hooks and heads are ineffective in compression. No data are available to demonstrate that hooks and heads can reduce development length in compression.

R25.4.1.3 The strength reduction factor ϕ is not used in the development length and lap splice length equations. An allowance for strength reduction is already included in the expressions for determining development and splice lengths.

R25.4.1.4 Darwin et al. (1996) shows that the force developed in a bar in development and lap splice tests increases at a lesser rate than $\sqrt{f_c'}$ with increasing compressive strength. Using $\sqrt{f_c'}$, however, is sufficiently accurate for values of $\sqrt{f_c'}$ up to 8.3 MPa, and because of the long-standing use of the $\sqrt{f_c'}$ in design, ACI Committee 318 has chosen not to change the exponent applied to the compressive strength used to calculate development and lap splice lengths, but rather to set an upper limit of 8.3 MPa on $\sqrt{f_c'}$.

R25.4.2 *Development of deformed bars and deformed wires in tension*

R25.4.2.1 This provision gives a two-tier approach for the calculation of tension development length. The user can either use the simplified provisions of 25.4.2.3 or the general development length equation (Eq. (25.4.2.4a)), which is

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