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Prediction of transfer lengths based on cohesive cracking

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The integrity of the prestressed concrete members mainly depends on bond between the surrounding concrete and the steel tendon. This is an important design consideration as both the flexural capacity and shear resistance are affected by the bond strength. Especially for a member that is subjected to high moments near their ends, such as cantilevers, railroad ties and short beams etc. it is vital to predict the transfer length with confidence. Accurate estimation of prestress transfer bond based on experiment is a difficult task and is a very expensive exercise because it requires high quality material, highly skilled labour, appropriate instrumentation and a data acquisition system to monitor.

The use of high strength concrete, restricted cover and spacing conditions together with use of large diameter strands in prestressed concrete members have been increasing significantly over the years. However, the recent experimental evidences suggest that the existing code provisions do not address the bond strengths adequately. In this study, a theoretical basis has been developed based on thick-cylinder theory to predict the bond mechanism between concrete and strand. For a confined situation there are several conditions of bond development. These depend on the ability of steel to swell upon tension release and the ability of concrete to resist swelling due to the expansion of the interface. The resulting hollow concrete cylinder cracks to the surface at the beginning of transfer followed by partial or internal cracking and finally there is an uncracked region. The uncracked parts of the concrete are treated as an isotropic material while cracked concrete parts are treated as an anisotropic material. The key feature here is that concrete continues to transmit tension through cracks of concrete. The model results show excellent correlation with experimental results collected from various research work.

For the outer radius of the concrete cylinder the minimum of side and bottom cover could be utilized where the radial stress at the outer surface is zero. However when the spacing is critical this condition does not prevail. In fact the concrete has higher strength. The results show that an additional 10 mm can be added to the outer surface of the concrete to impose the same boundary condition. Comparison of both theoretical and experimental result gives a good correlation. These results also confirm the validity of the theory.

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