306/C

Critical review of shear design procedures related to reinforced concrete beams

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Shear design of reinforced concrete beams has always been uncertain as the true nature of the supporting mechanism has not been clear. Throughout the years various models in research have been adopted to fit the true behaviour of the beams in shear, while some models have been incorporated in major codes of practice without adequate verification. This study attempts to evaluate key approaches and compare the results to expose the large differences associated with such practices.

In hindsight it is seen that the various truss models used as a theoretical basis has actually hindered our understanding rather than helping it. For the purpose of review the basic truss model, compression field theory, modified compression field theory, simplified method and shear friction have been considered in this study. These approaches have been adopted because they appear to be logical and fit neatly with our understanding of trusses. However these models have been made more and more complicated in order to provide a reasonable fit with test results. A common example in literature (200 mm x 400 mm x 5 m) having a rectangular shape and loaded with a concentrated load of 150 kN at mid-span has been used for the comparison. According to the flexural design 3 bars of 16 mm Tor steel at the top and 3 bars of 25 mm Tor steel at the bottom have been used as the main reinforcement. For the shear design a round bar of 10 mm mild steel was chosen for the stirrups. Normally the failure of beams due to shear depends on the loading stage of the beam reflecting magnitudes and patterns of the load. Although there is a comprehensive amount of data based on test results a test series aimed to facilitate computations based on all five methods has been adopted in this study.

Designs show spacing of shear reinforcement should be provided as 180 mm (basic truss model), 165 mm (compression field theory), 345 mm (modified compression field theory), 380 mm (simplified method) and 330 mm (shear friction). In summary, these results reveal that there are large differences and similarities with the currently used approaches as seen for the present example. It can be concluded both truss model and compression field theory underestimates the shear capacity. In fact other 3 methods have twice the capacity. This difference can be attributed to the contribution of concrete parts in tension. Here cracked concrete continue to transmit tension across cracks.

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