Shear in Concrete Structures - A Historical Overview

by

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Abstract

The design and analysis of shear in concrete structures will be presented from a historical point of view, starting with Navier's three principles of mechanics of materials (stress equilibrium, strain compatibility and constitutive laws of materials) developed in 1826. This will be followed by the story of how Navier's principles were applied to reinforced concrete structures and how they guided the development of shear theories up to the present days, including the rotating-angle theory, the fixed-angle thoery, and the softened membrane model. Emphasis will be placed on the most recent shear theories, "Cyclic Softened Membrane Model" (ASCE Structural Journal, Jan. 2005), developed at the University of Houston. This analytical model can accurately predict the load-deformation hysteretic loops of reinforced concrete elements and rationally explain the "pinching effect." As a result, it can predict the shear stiffness, the shear ductility and the energy dissipation capacity of reinforced concrete elements. This powerful model has been implemented into the non-linear finite element program (OpenSEE) developed at University of California, Berkeley (Fenves, 2000), to analyze the cyclic and seismic behavior of wall-type structures.