ABSTRACT

This study evaluates Abaqus's Concrete Damage Plasticity (CDP) model for simulating the axial stress-strain response of plain and CFRP-wrapped concrete cylinders. Three specimens from Comber et al.'s full-scale tests were chosen: an unwrapped cylinder (C-0) and cylinders wrapped with two (C-2) and six (C-6) CFRP layers. The published load-displacement curves were digitized in WebPlotDigitizer and processed in Excel to form smooth reference stress-strain data. Three-dimensional Abaqus/Standard models used a 60 mm hexahedral mesh for the concrete core and single-element, reduced-integration S4R shells for the CFRP wrap to speed up the analysis. Concrete behavior was governed by CDP parameters calibrated in prior studies (dilation angle $\psi = 40°$, eccentricity $\varepsilon = 0,10$, biaxial/uniaxial strength ratio $f_{b0}/f_{c0} = 1,16$, shape factor $K = 0,667$ and viscosity $\mu = 1 \times 10^{-4}$); CFRP damage initiation and evolution followed Hashin criteria.

The simulation underpredicts C-0 peak stress by 4% (35,400 MPa vs 36,920 MPa) and peak strain by 7,2% (0,00167 vs 0,00180). For C-2 it underpredicts peak stress by 24,7% (43,810 MPa vs 58,100 MPa) while matching peak strain within 0,06% (0,009395 vs 0,009400). In C-6 the predicted peak stress is within + 5,49% (103,620 MPa vs 98,220 MPa) and the peak strain is reproduced exactly (0,01650). Post-peak behavior aligns closely with the experimental plateau only in the highly confined C-6 case; C-2 still shows mild softening. These findings confirm that, with literature-based CDP inputs and reduced-integration shells, Abaqus can capture both strength and ductility trends of CFRP-wrapped concrete cylinders, though refined damage-evolution laws may be needed for lightly confined specimens.

Keywords: Concrete Damage Plasticity, CFRP confinement, Axial stress–strain, Finite element simulation, Abaqus