

# Normal-Strength and Ultra-High-Performance Concrete Behavior

## Introduction

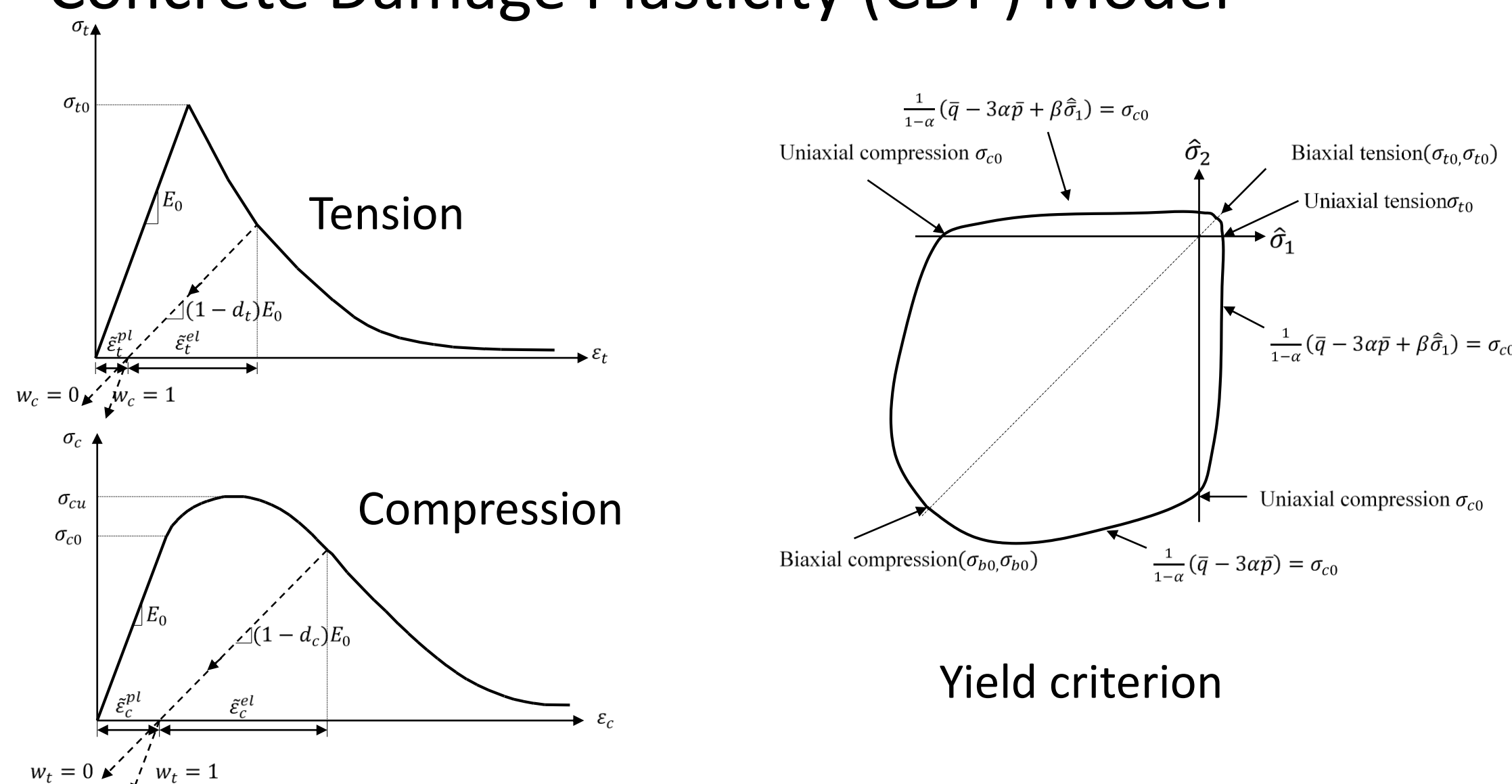
- Ultra-high-performance concrete (UHPC) is a relatively new cementitious material with a highly optimized cement matrix of only fine aggregates and low water-cement ratio
- To overcome brittleness, steel or synthetic fibers are added to produce ultra-high-performance fiber-reinforced concrete (UHPC)
- The behavior of such materials under a wide range of loading rates is not well understood
- Reliable comparisons with the behavior of normal-strength concrete (NSC) are not available

## Objectives

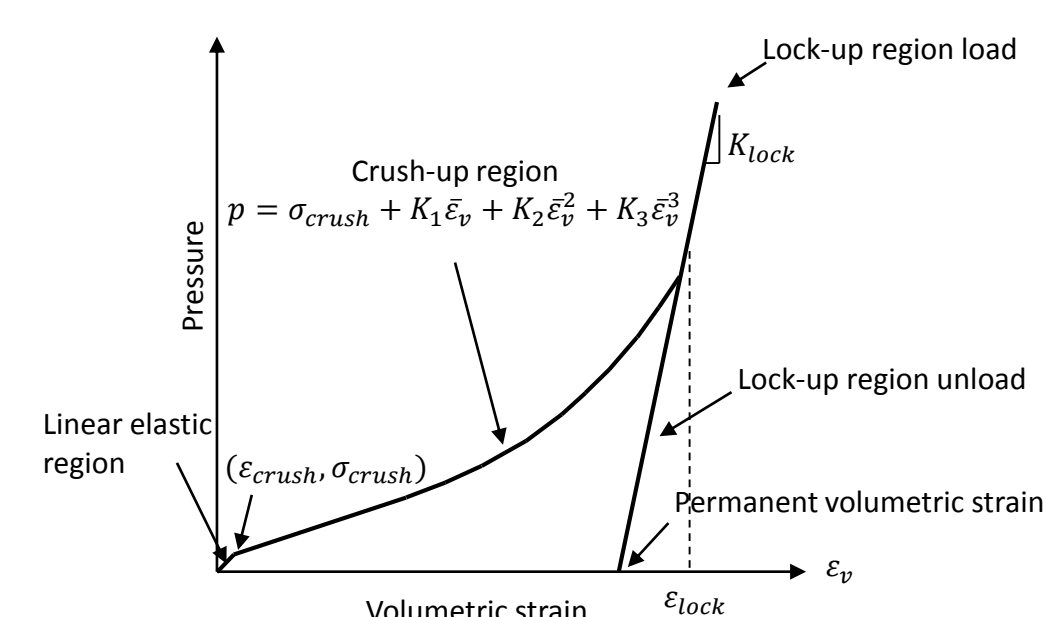
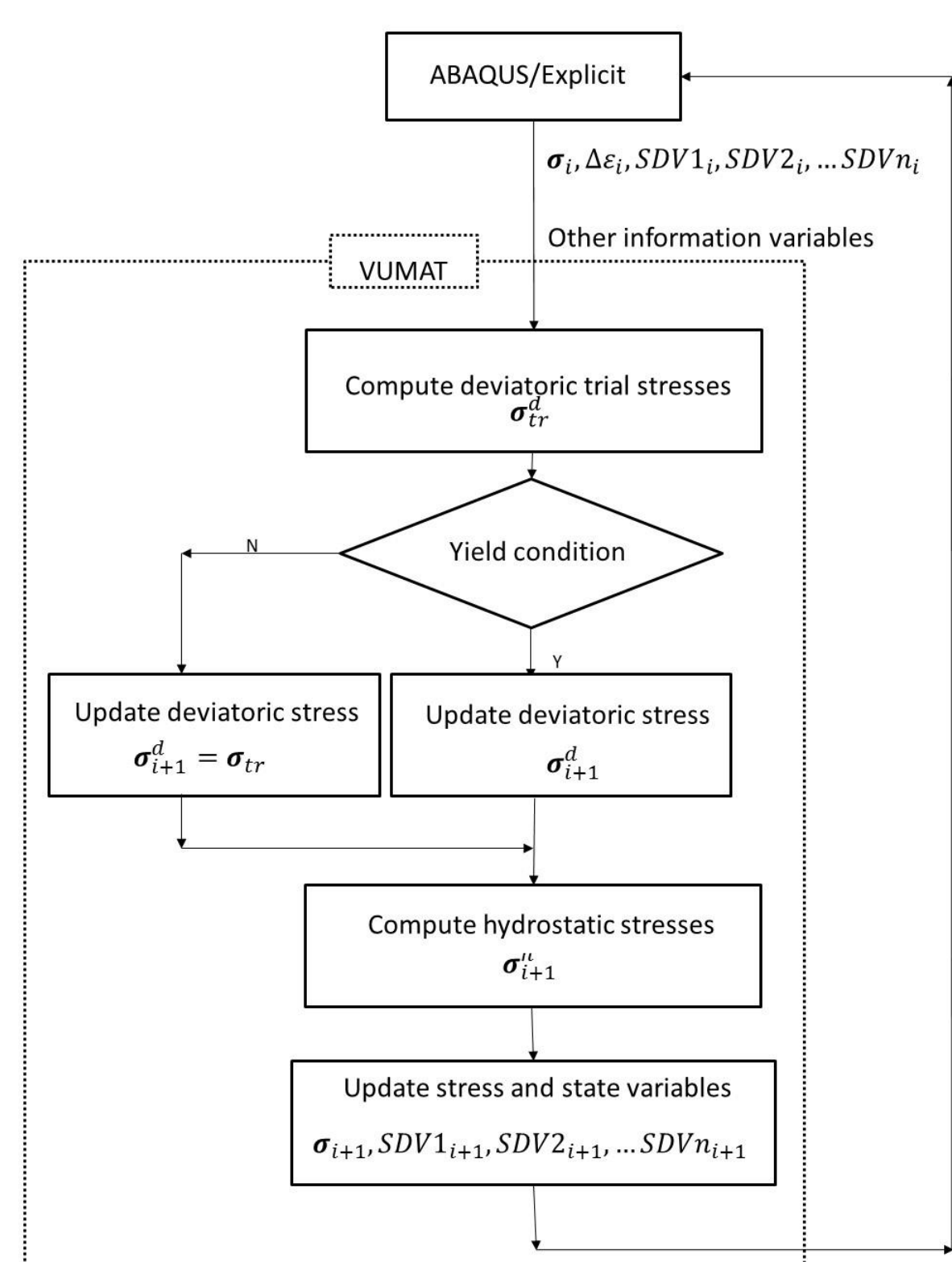
- Develop constitutive models suitable for modeling the response of UHPC and UHPC members under static and dynamic loads for:
  - High-fidelity continuum based finite element analysis (FEA) approach
  - Fast-running advanced single-degree-of-freedom based (SDOF) analysis approach
- Validate and calibrate these constitutive models using static and impact test results from cylinder and beam tests
- Compare the results with those for identical test elements made of NSC

## Constitutive Models in ABAQUS/Explicit

### Concrete Damage Plasticity (CDP) Model



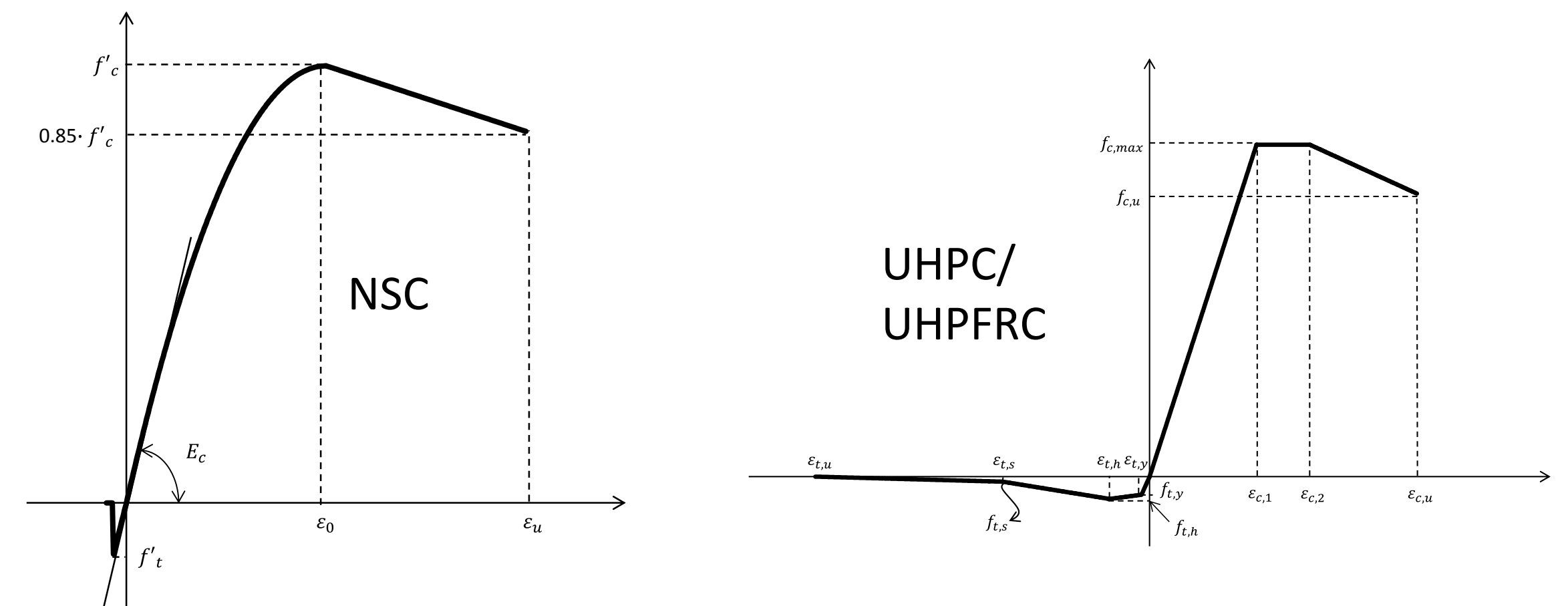
### Advanced Fundamental Concrete (AFC) Model



## Research Approach

- COR-TUF, developed and manufactured by US Army ERDC, was used as the UHPC (COR-TUF2) and UHPFRC (COR-TUF1) materials. COR-TUF1 has 3.5% steel fibers in the mix whereas COR-TUF2 is plain UHPC
- SAM-35, a 3500 psi concrete mix also developed and manufactured by US Army ERDC was used as NSC benchmark
- Results from static and impact tests of COR-TUF1, COR-TUF2, and SAM-35 cylinders and full-scale beams were used to validate and calibrate the models.
- The Advanced Fundamental Concrete (AFC) model was added to ABAQUS/Explicit.
- Constitutive model parameters were established for the Concrete Damage Plasticity (CDP) and AFC models in ABAQUS/Explicit
- A UHPC specific constitutive model was added to the advanced SDOF program DSAS

## Constitutive Models in DSAS



## Comparisons with Test Results

