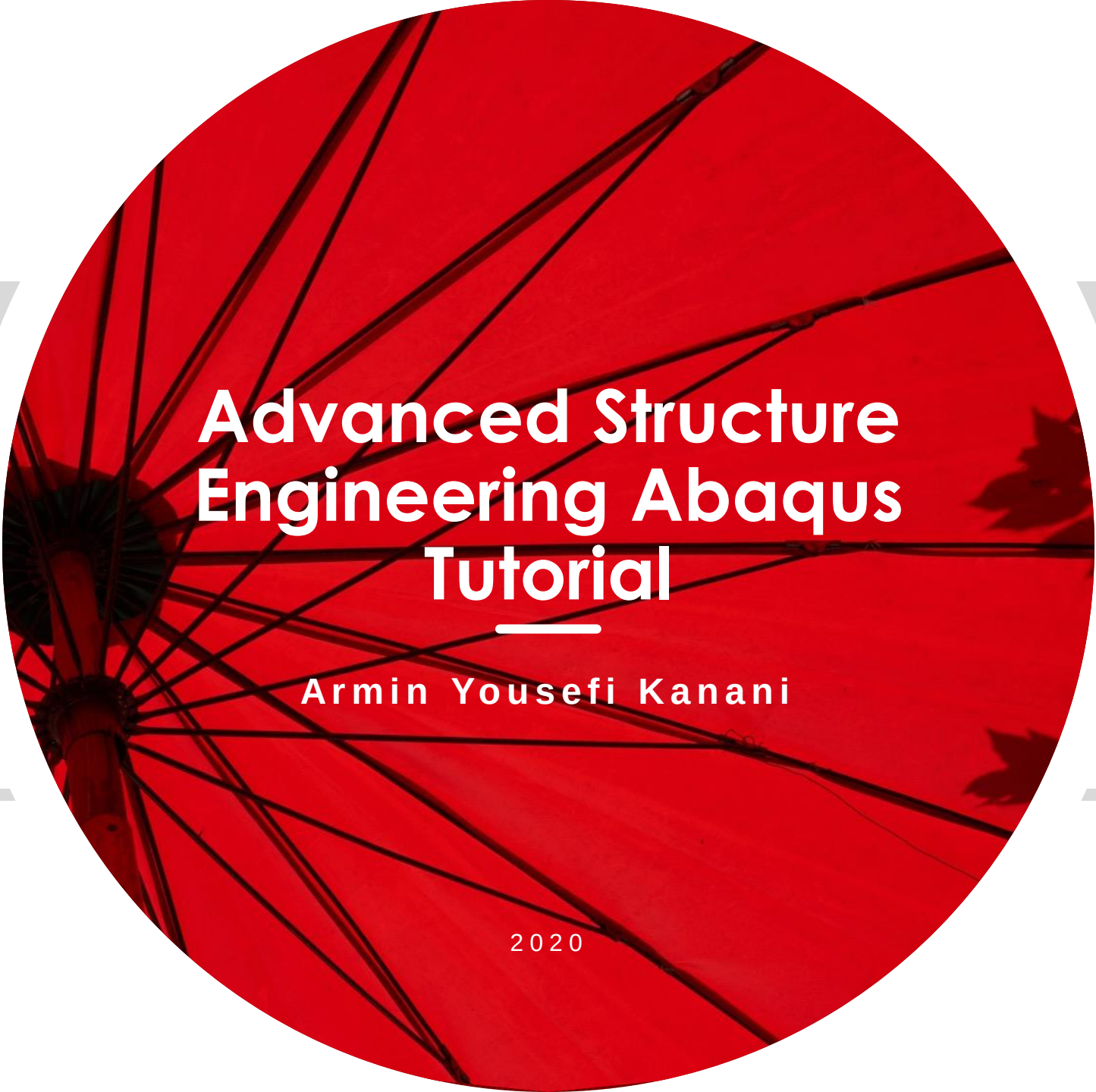




Advanced Structure Engineering Abaqus Tutorial

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2020

► Concrete Damaged Plasticity (CDP)



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What is Concrete damaged plasticity (CDP)?

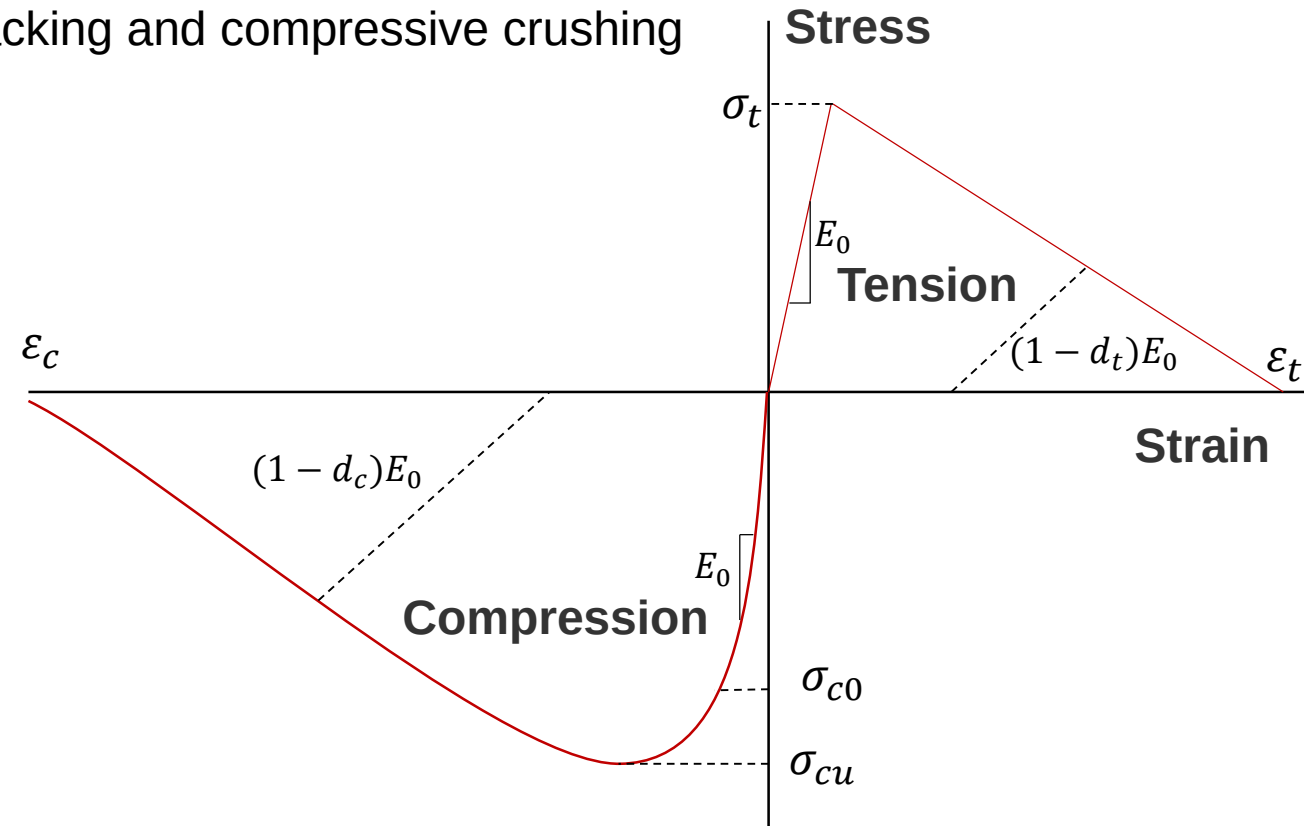
The model is a continuum, plasticity-based, damage model for concrete. It assumes that the main two failure mechanisms are tensile cracking and compressive crushing of the concrete material.

- E_0 = (undamaged) elastic stiffness of the material
- The damage plasticity constitutive model was based on the following stress–strain relationship:

$$\sigma = (1 - d_c)\bar{\sigma}_c + (1 - d_t)\bar{\sigma}_t$$

- The total strain tensor ε was comprised of the elastic part ε^{el} and the plastic part ε^{pl}

$$\varepsilon = \varepsilon^{el} + \varepsilon^{pl}$$



What do we need as an input for concrete?

Edit Material

Name: UHPC

Description:

Material Behaviors

Concrete Damaged Plasticity

General Mechanical Thermal Electrical/Magnetic

Concrete Damaged Plasticity

Plasticity **Compressive Behavior** Tensile Behavior

☐ Use strain-rate-dependent data

☐ Use temperature-dependent data

Number of field variables: 0

Data

	Yield Stress	Inelastic Strain
1		

Suboption Editor

Concrete Compression Damage

Tension recovery:

☐ Use temperature-dependent data

Number of field variables: 0

Data

	Damage Parameter	Inelastic Strain
1		

Suboptions

OK Cancel

Edit Material

Name: UHPC

Description:

Material Behaviors

Concrete Damaged Plasticity

General Mechanical Thermal Electrical/Magnetic

Concrete Damaged Plasticity

Plasticity Compressive Behavior **Tensile Behavior**

Type: Strain

☐ Use strain-rate-dependent data

☐ Use temperature-dependent data

Number of field variables: 0

Data

	Yield Stress	Cracking Strain
1		

Suboption Editor

Concrete Tension Damage

Type: Strain

Tension recovery:

☐ Use temperature-dependent data

Number of field variables: 0

Data

	Damage Parameter	Cracking Strain
1		

Suboptions

OK Cancel



Flow rules:

The plastic-damage model assumes non-associated potential flow, which means that the yield functionality and plastic potential does not occur at the same time. The flow potential G chosen for this model is the Drucker-Prager hyperbolic function:

Dilation Angle

Dilation angle, ψ , in the p - q plane. (The horizontal axis, p , indicates the mean stress, while the vertical axis, q , indicates the deviatoric stress).

Eccentricity

Flow potential eccentricity (ε). The eccentricity is a small positive number that defines the rate at which the hyperbolic flow potential approaches its asymptote. The default value is $\varepsilon = 0.1$.

fb0/fc0

the ratio of initial equibiaxial compressive yield stress to initial uniaxial compressive yield stress. The default value is 1.16.

k

k_c , the ratio of the second stress invariant on the tensile meridian, q_{TM} , to that on the compressive meridian, q_{CM} , at initial yield for any given value of the pressure invariant p such that the maximum principal stress is negative, σ_{max} . It must satisfy the condition $0.5 < k_c < 1.0$. The default value is $2/3$.

Viscosity Parameter

Viscosity parameter, μ , used for the visco-plastic regularization of the concrete constitutive equations in Abaqus/Standard analyses. This parameter is ignored in Abaqus/Explicit. The default value is 0. (Units of .)

The screenshot shows the 'Edit Material' dialog box for a material named 'UHPC'. The 'Concrete Damaged Plasticity' model is selected. The 'Plasticity' tab is active, showing 'Compressive Behavior' and 'Tensile Behavior' sub-tabs. The 'Use temperature-dependent data' checkbox is unchecked. The 'Number of field variables' is set to 0. A table with 5 columns (Dilation Angle, Eccentricity, fb0/fc0, K, Viscosity Parameter) and 1 row (all cells empty) is present. Below the table, the Drucker-Prager hyperbolic function is displayed:
$$G = \sqrt{(\epsilon \sigma_{t0} \tan \psi)^2 + \bar{q}^2} - \bar{p} \tan \psi,$$

	Dilation Angle	Eccentricity	fb0/fc0	K	Viscosity Parameter
1					

How to find these parameters?

1. Tomasz Jankowiak, Tomasz Lodygowski, Identification of parameters of concrete damage plasticity constitutive model, Found. Civil Environ. Eng. 6 (1) (2005) 53–69.
2. Linfeng Chen, Benjamin A. Graybeal, Finite Element Analysis of Ultra-High Performance Concrete: Modeling Structural Performance of An AASHTO Type II Girder and a 2nd Generation Pi-Girder, No. FHWA-HRT-11-020, 2010.
3. Mohamadreza Shafieifar, Mahsa Farzad, Atorod Azizinamini, Experimental and numerical study on mechanical properties of Ultra High Performance Concrete (UHPC), Construction and Building Materials, Volume 156, 2017, Pages 402-411, ISSN 0950-0618,

Model the following laboratory tests are necessary (Ref [1]):

- the uniaxial compression,
- the uniaxial tension,
- the biaxial failure in plane state of stress
- the triaxial test of concrete



Simplified CDP model (SCDP):

1. Milad Hafezolghorani (PhD Candidate), Farzad Hejazi (Senior Lecturer), Ramin Vaghei (PhD), Mohd Saleh Bin Jaafar (Prof.) & Keyhan Karimzade (Msc) (2017) Simplified Damage Plasticity Model for Concrete, Structural Engineering International, 27:1, 68-78, DOI: 10.2749/101686616X1081



THANK YOU!



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