Sensivity to change in the length scale
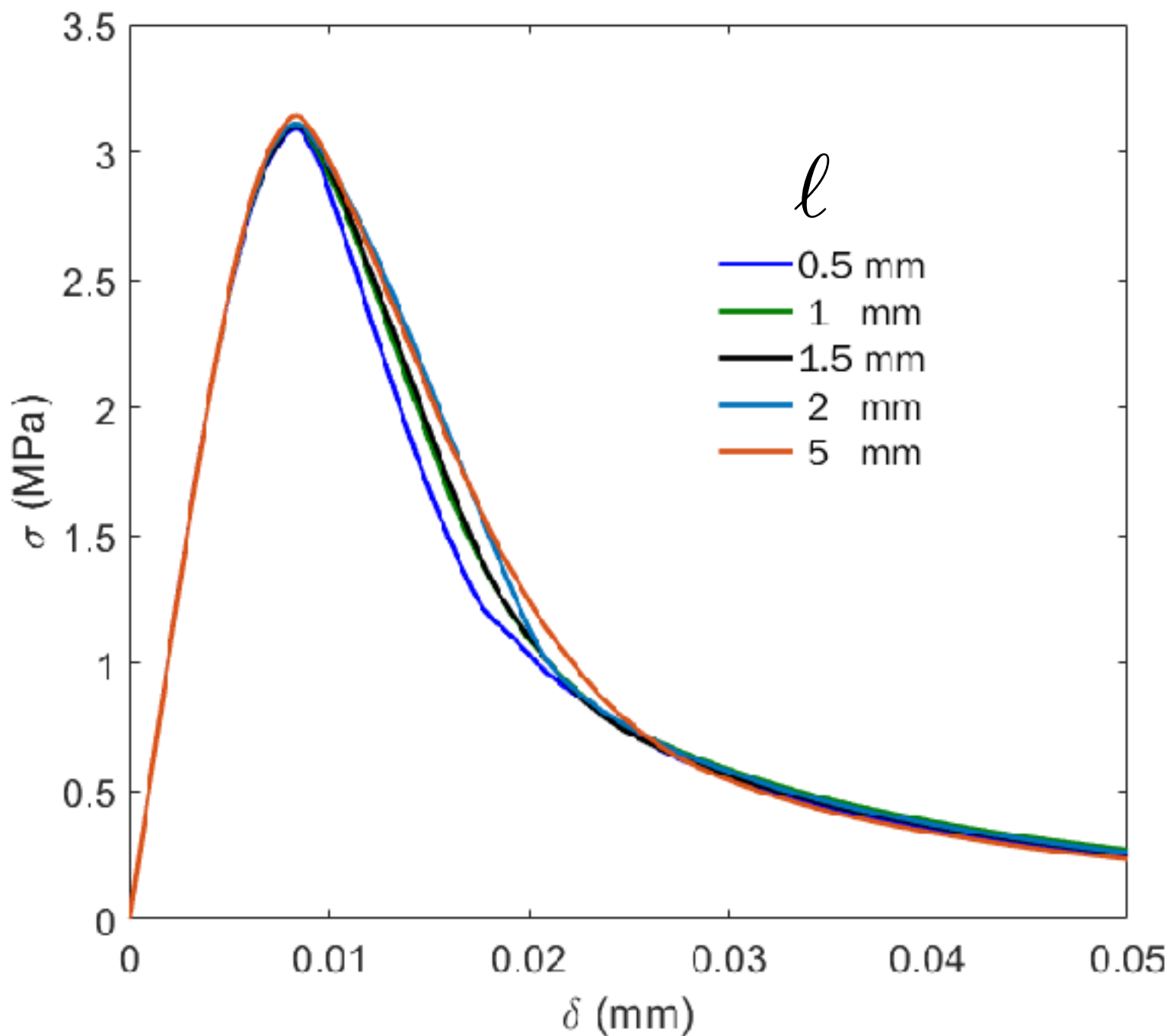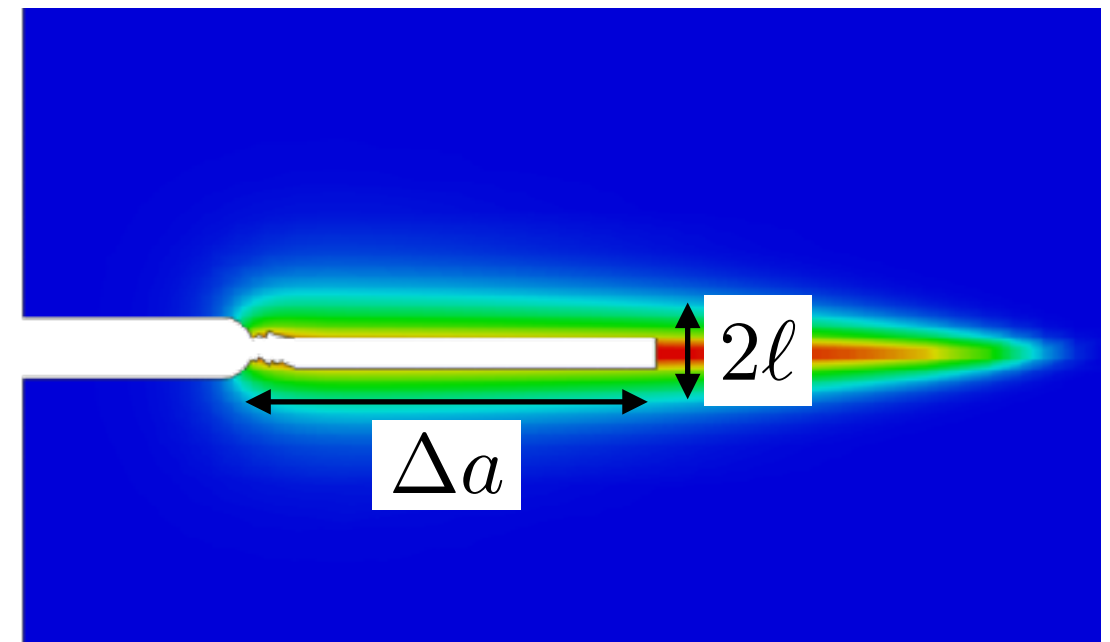

- Energy dissipated in the shown volume

$$\propto \psi_* \ell \Delta a$$

- The energy dissipated per unit surface area of crack extension

$$\propto \psi_* \ell$$

$$\psi_* \ell = \text{constant}$$

Comprehensive concrete fracture tests: Description and results

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ARTICLE INFO

ABSTRACT

Although hundreds of concrete fracture tests exist, their evaluation is ambiguous because they have limited ranges of specimen size, initial notch depth and postpeak response, and refer to different concretes, different batches of concrete, different ages, different environmental conditions, different loading rates and test procedures, and different specimen types. Presented is an experimental investigation of unprecedented comprehensiveness and low scatter, using specimens made from one batch of concrete. It includes: (1) notched and unnotched beams tested at virtually the same age; (2) crack depths ranging from 0% to 30% of beam depth; (3) a broad size range (1:12.5); (4) tests in transition between type 1 and type 2 size effects; (5) virtually complete postpeak softening data; (6) properly correlated loading rates; and (7) complete standard characterization of the concrete used. The analysis is relegated to a follow-up paper.
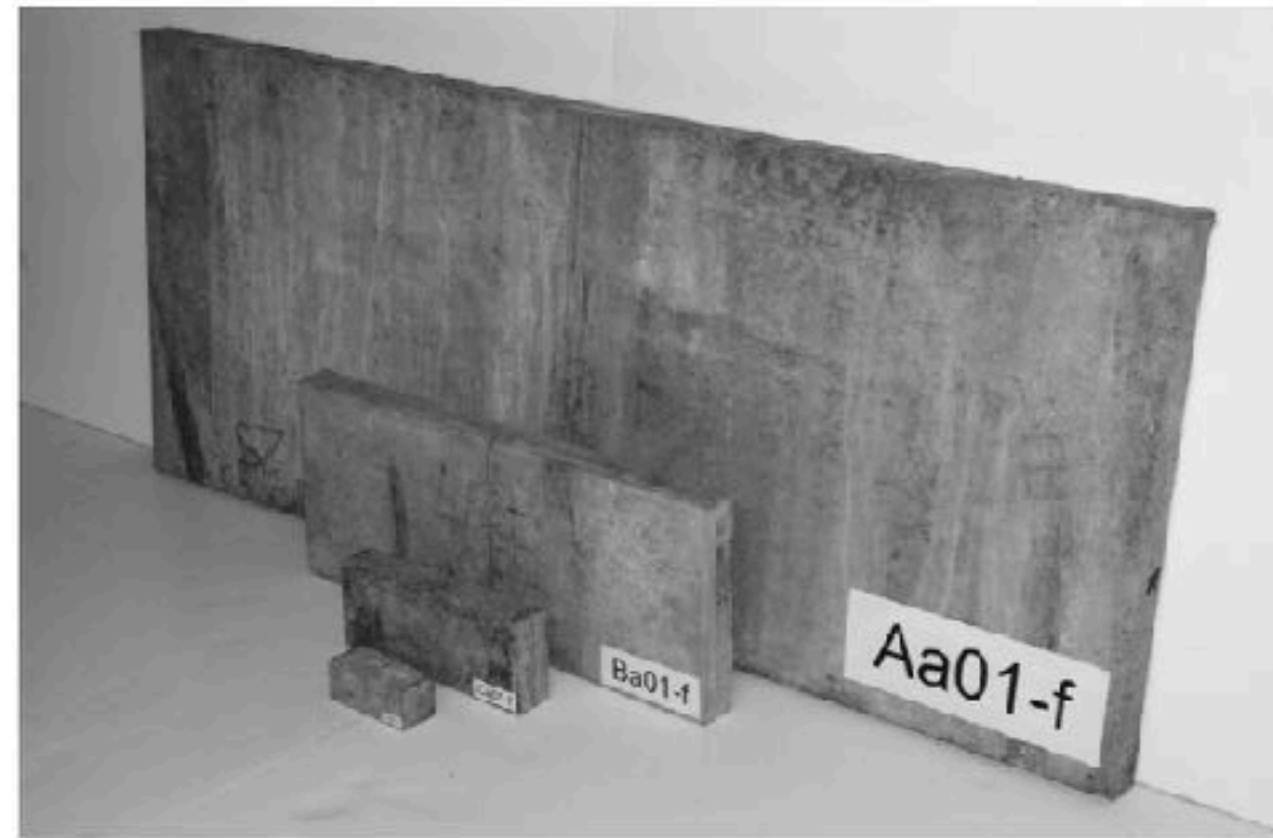
- Multi-million experimental research effort on concrete funded by DOT in 2013, to obtain pedigreed data from a single batch of concrete.

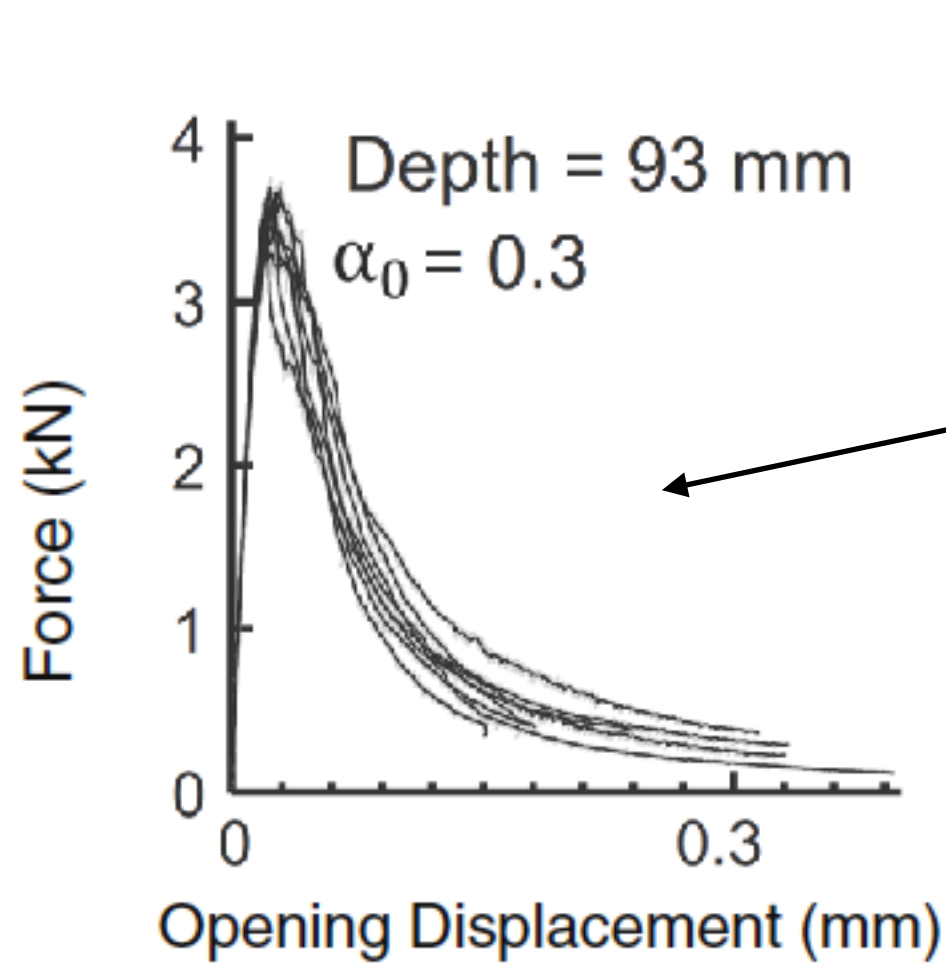# 3-Pt Bend tests of Bazant and co-workers
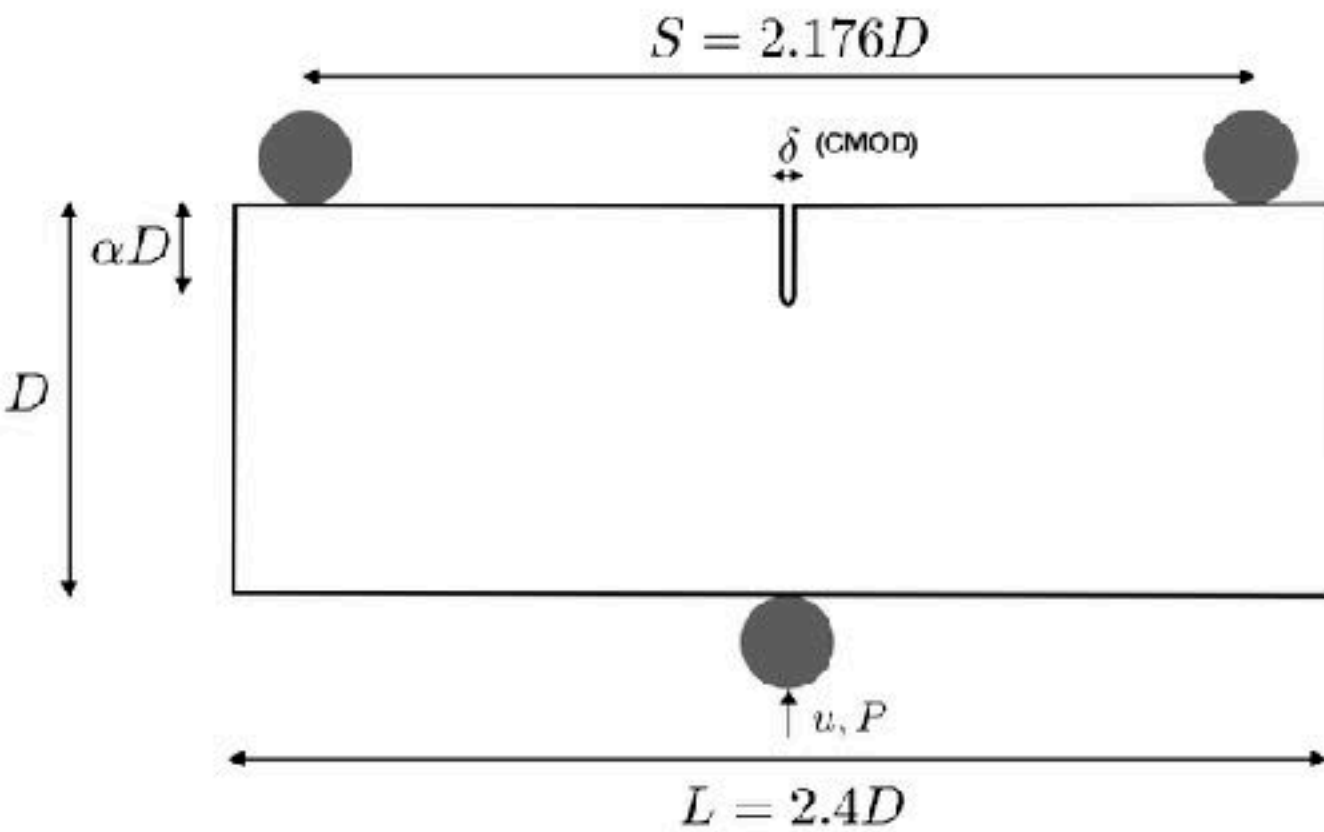
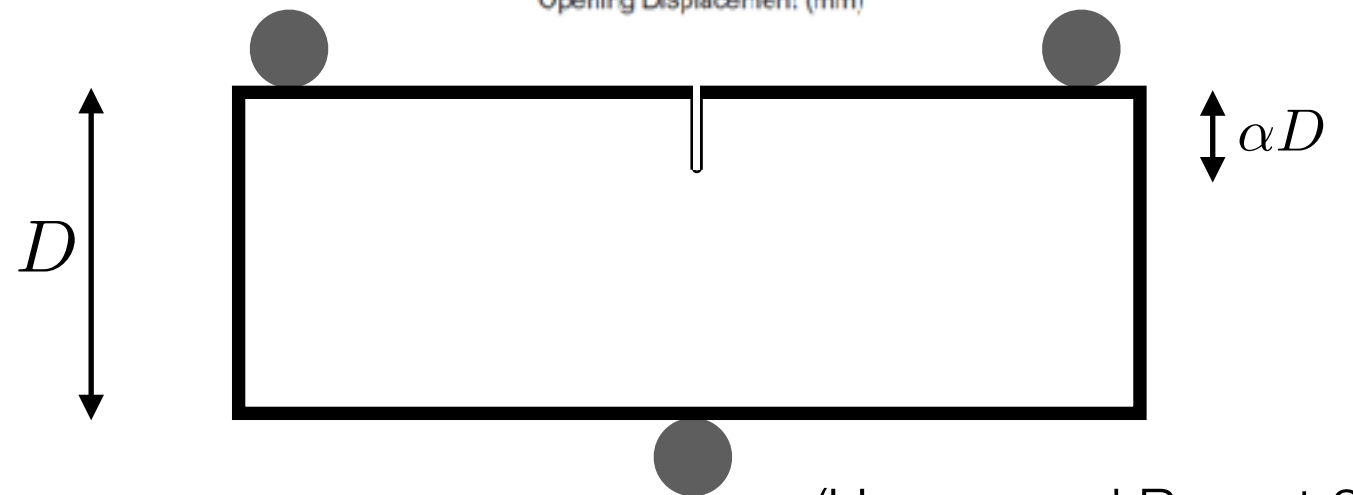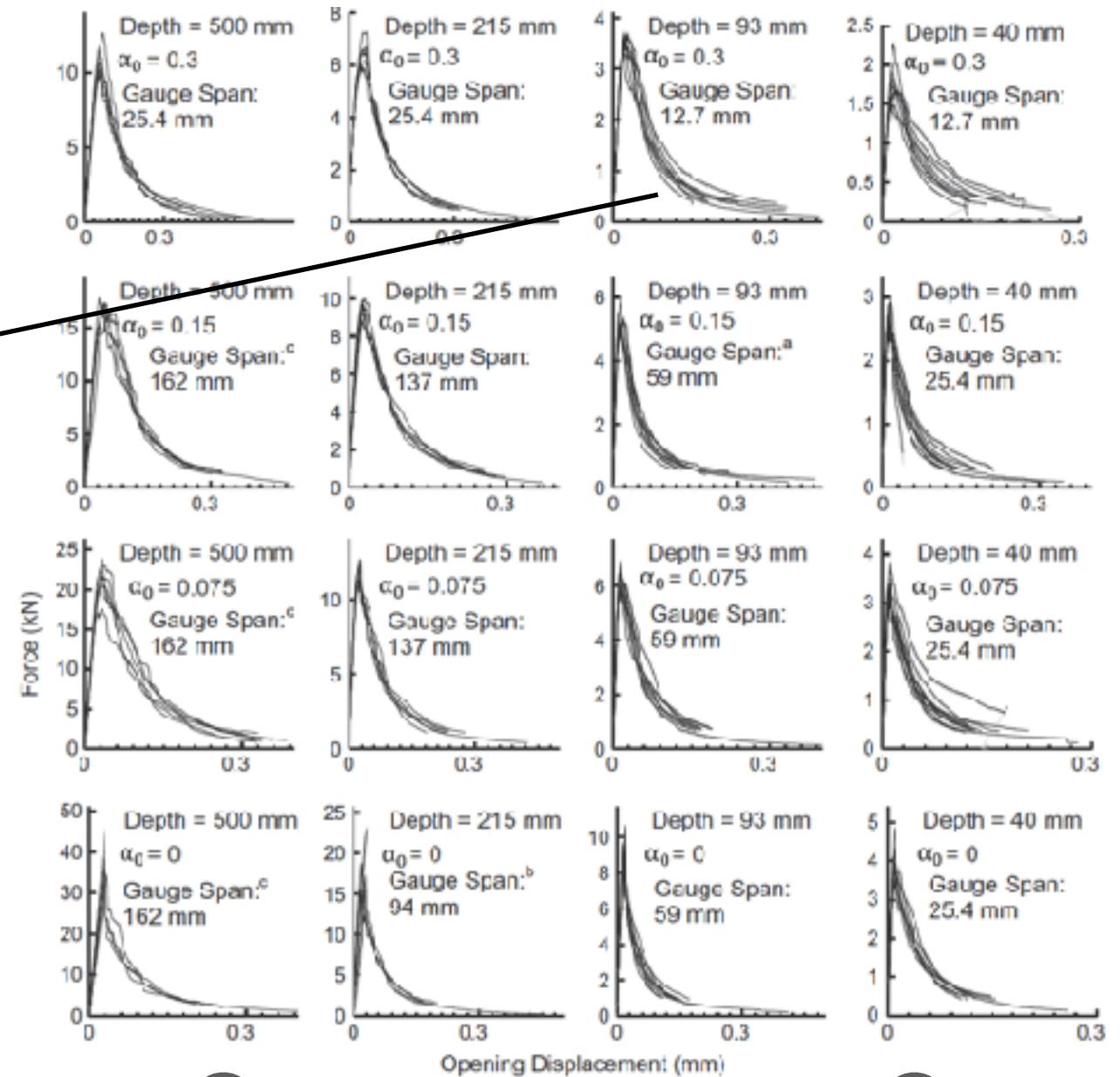Thickness of specimens: 40 mm

Notch width: 1.5 mm

D= 40 to 500 mm

Three point bend tests -Concrete

Depth = 93 mm
$\alpha_0 = 0.3$

Force (kN)

Opening Displacement (mm)

Aa01-f

D= 40 to 500 mm

(Hoover and Bazant,2013)
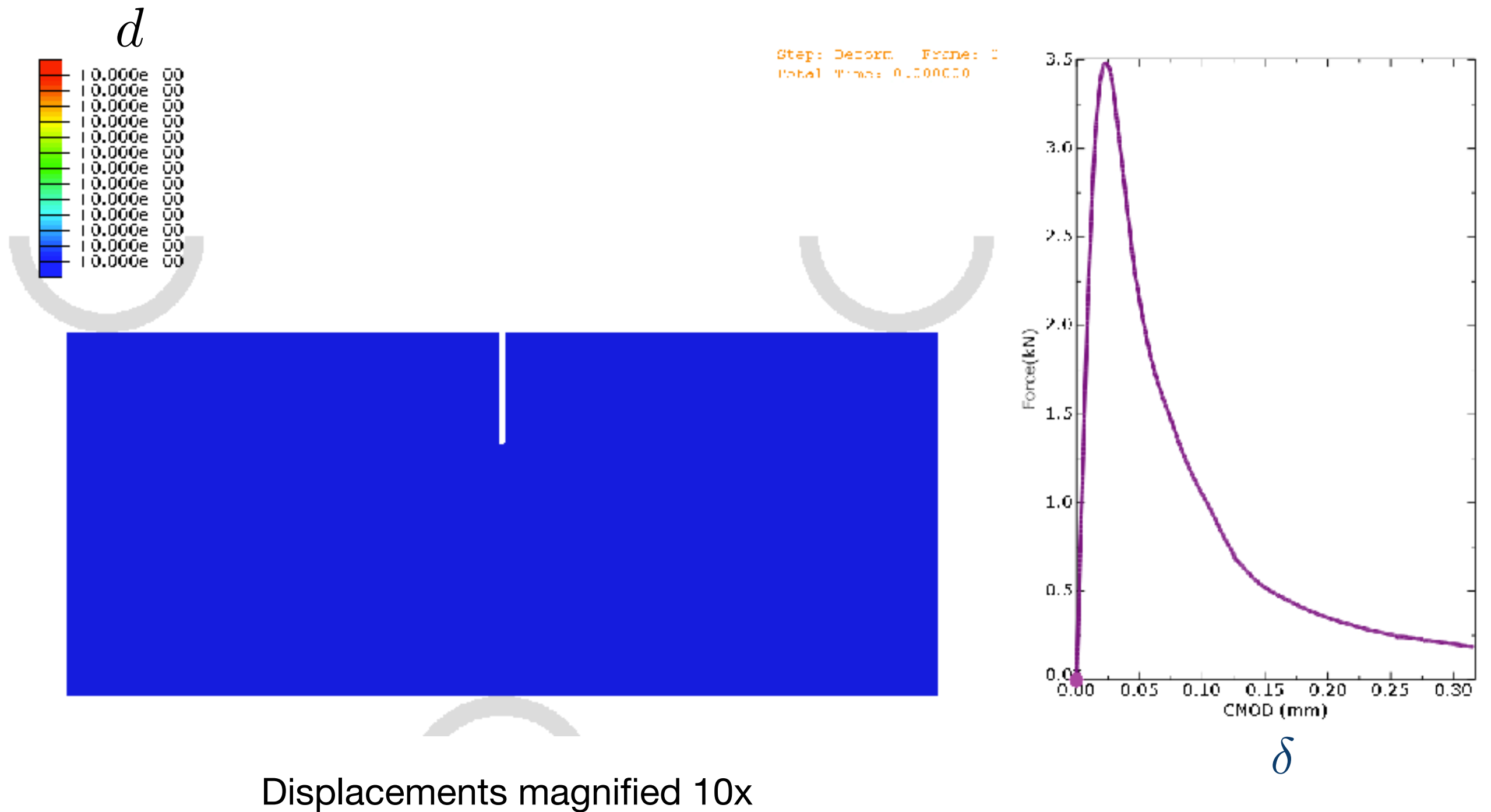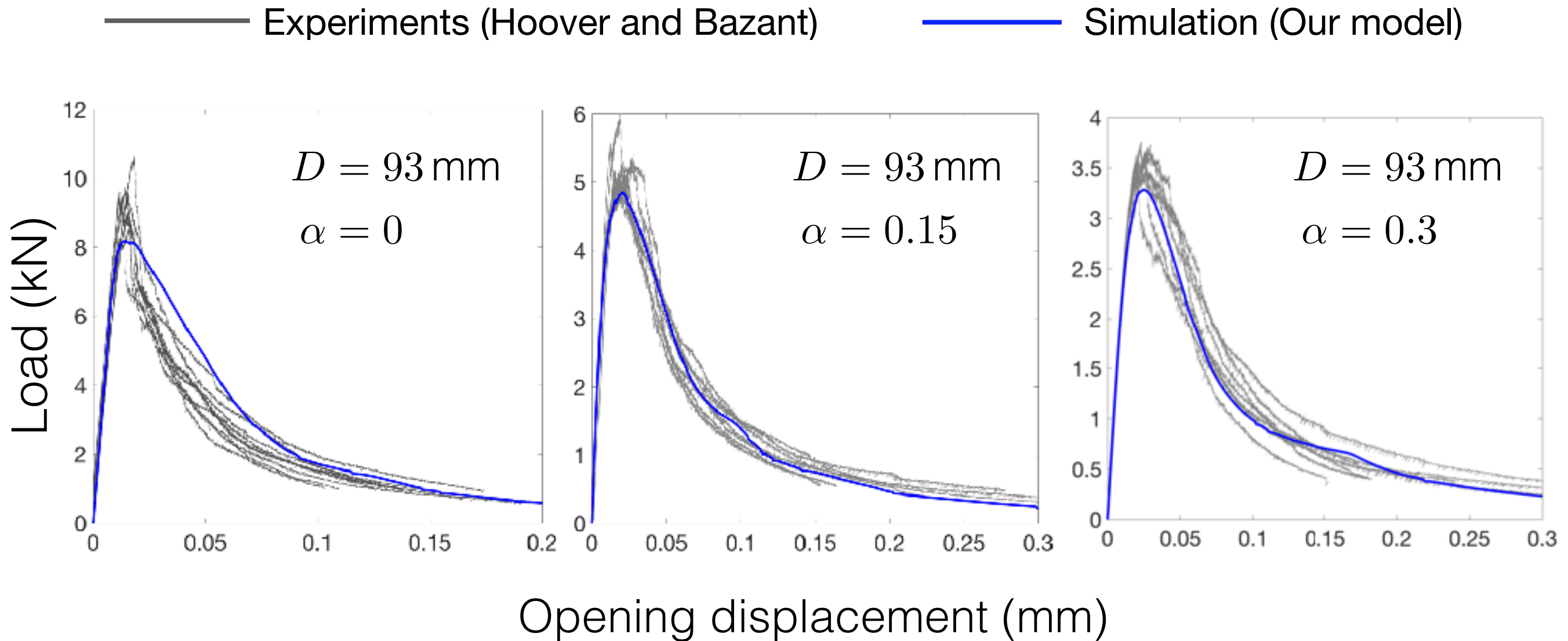
$$D = 93 \, \text{mm}$$

$$\alpha = 0.3$$

Displacements magnified 10x

Experiments (Hoover and Bazant) — Simulation (Our model)

Load (kN) vs Opening displacement (mm)

$D = 93\,\text{mm}$, $\alpha = 0$

$D = 93\,\text{mm}$, $\alpha = 0.15$

$D = 93\,\text{mm}$, $\alpha = 0.3$

Material Parameters

E	ν	S^c	$\varkappa$	ϵ^c_{crit}	ψ_*	ℓ	ζ
41	0.17	4.5	0.7	4.4×10^{-4}	3.8	2	40
GPa	-	MPa	-	-	kJ/m^3	mm	kPa-s
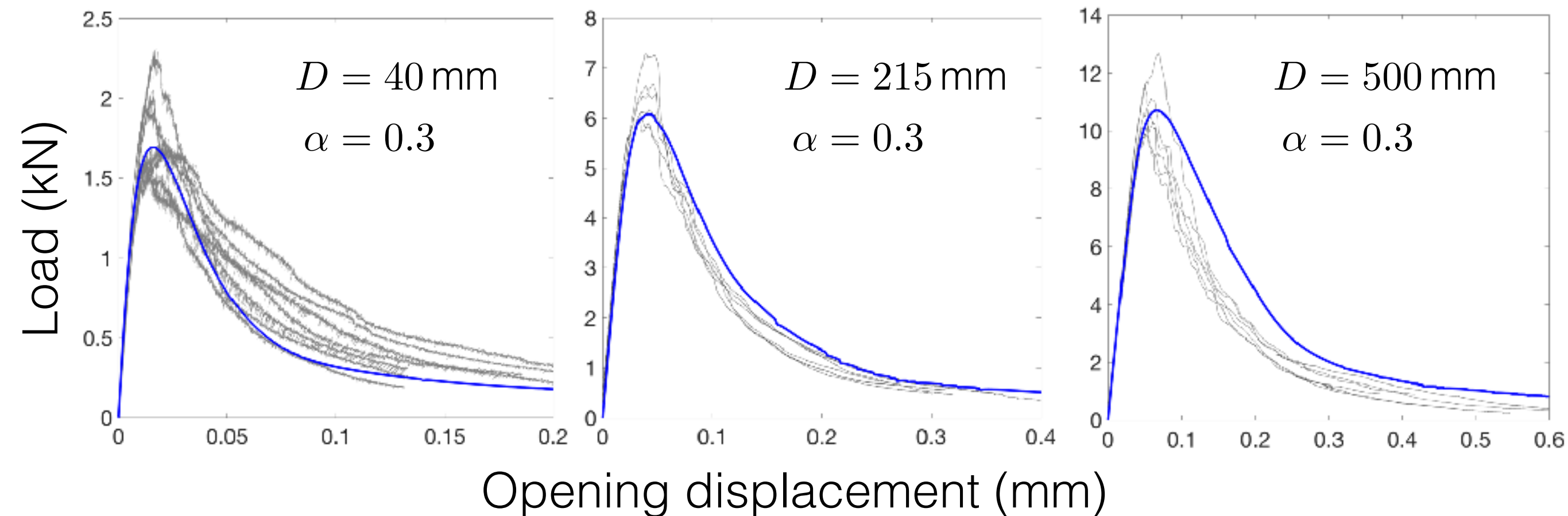
Material Parameters

E	ν	S^c	$\varkappa$	ϵ^c_{crit}	ψ_*	ℓ	ζ
41	0.17	4.5	0.7	4.4×10^{-4}	3.8	2	40
GPa	-	MPa	-	-	kJ/m^3	mm	kPa-s

Mixed-mode fracture tests

Asymmetric bend tests

Dimensions in mm

150

u,P

150

75

37.5

300

675

Notch width : 2 mm

300

150

u,P

(Galvez et al, 1998)
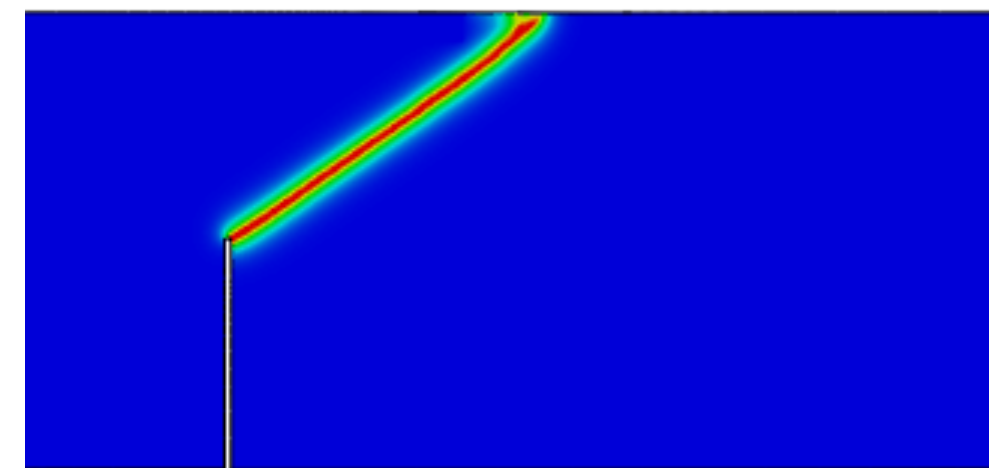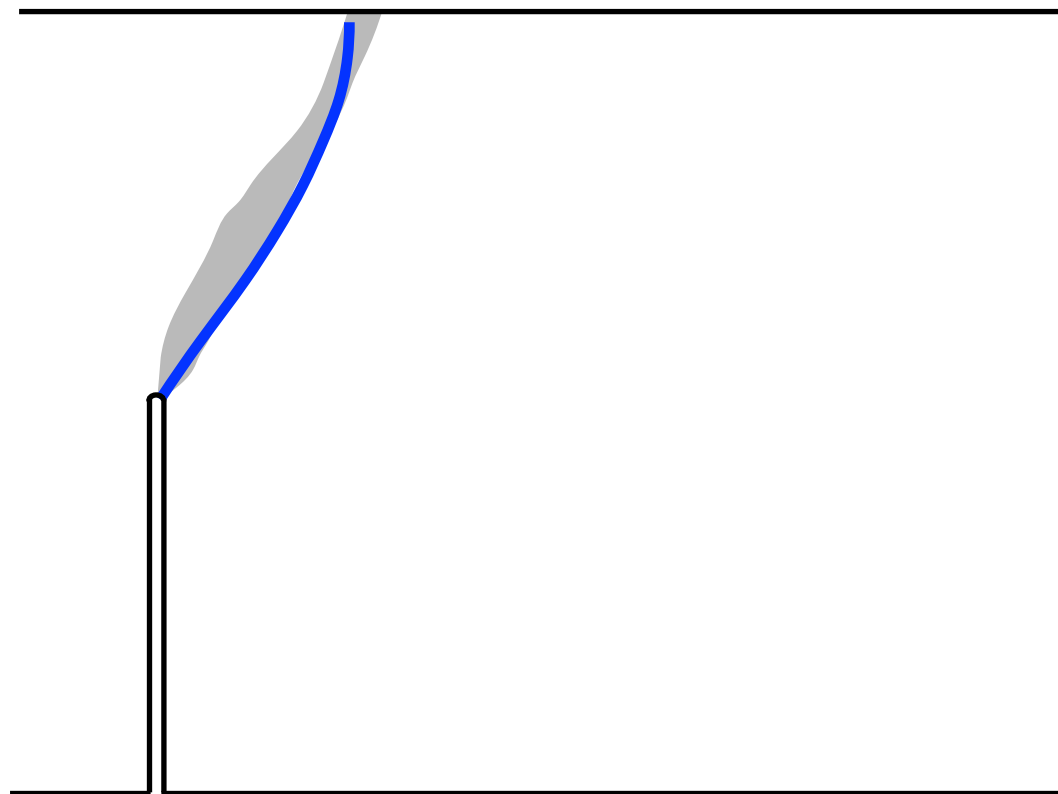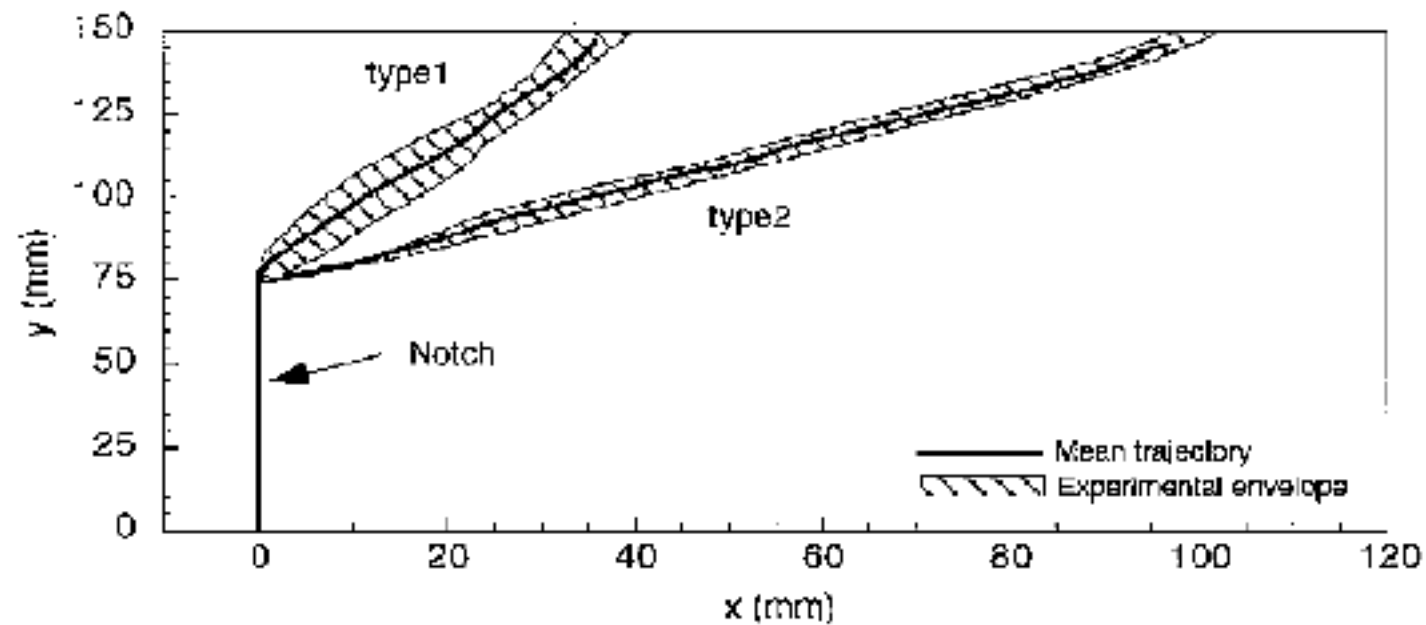
Thickness : 50

Three-point bend :
simulated crack path

Four-point bend :
simulated crack path

Comparison of predicted and measured crack paths
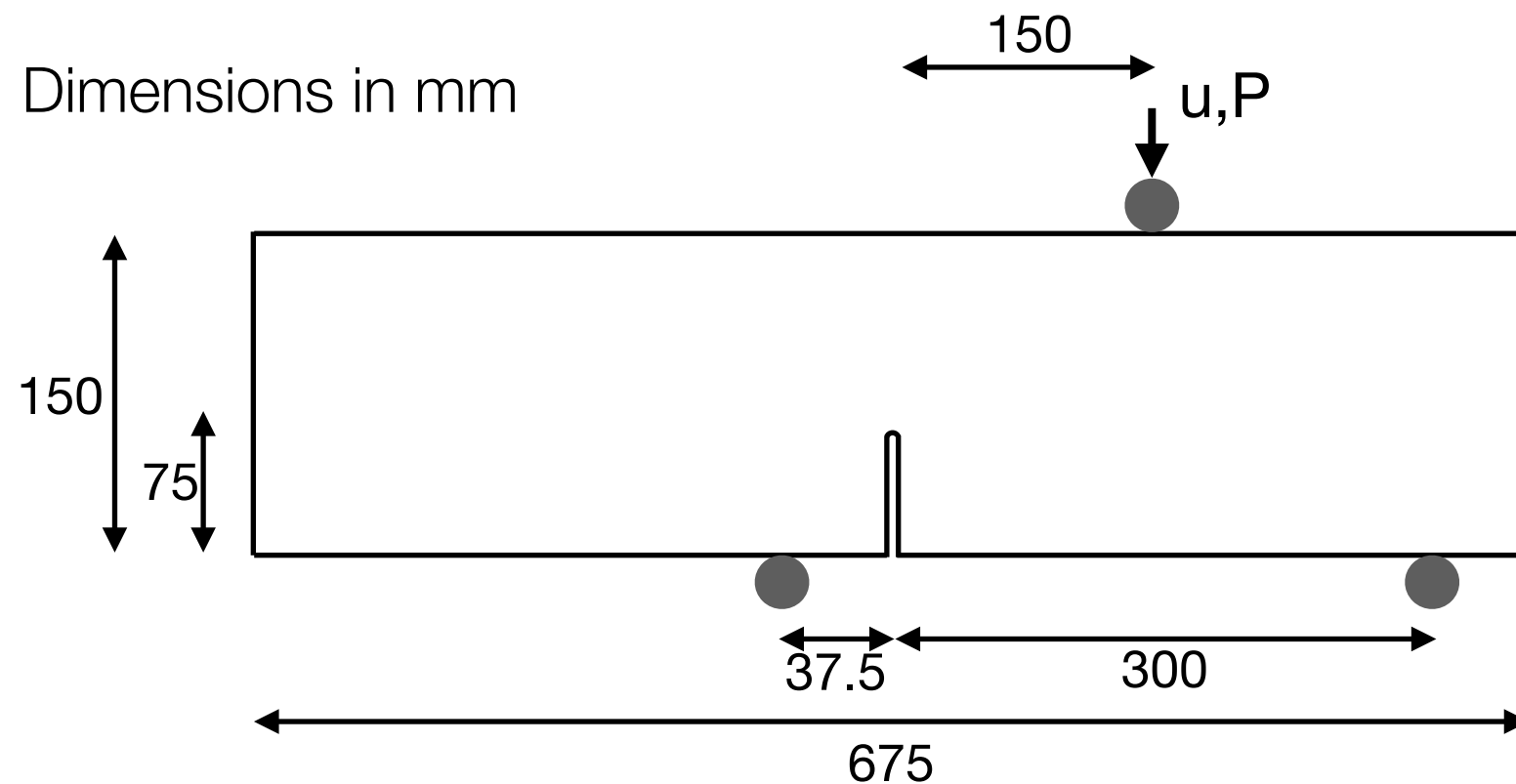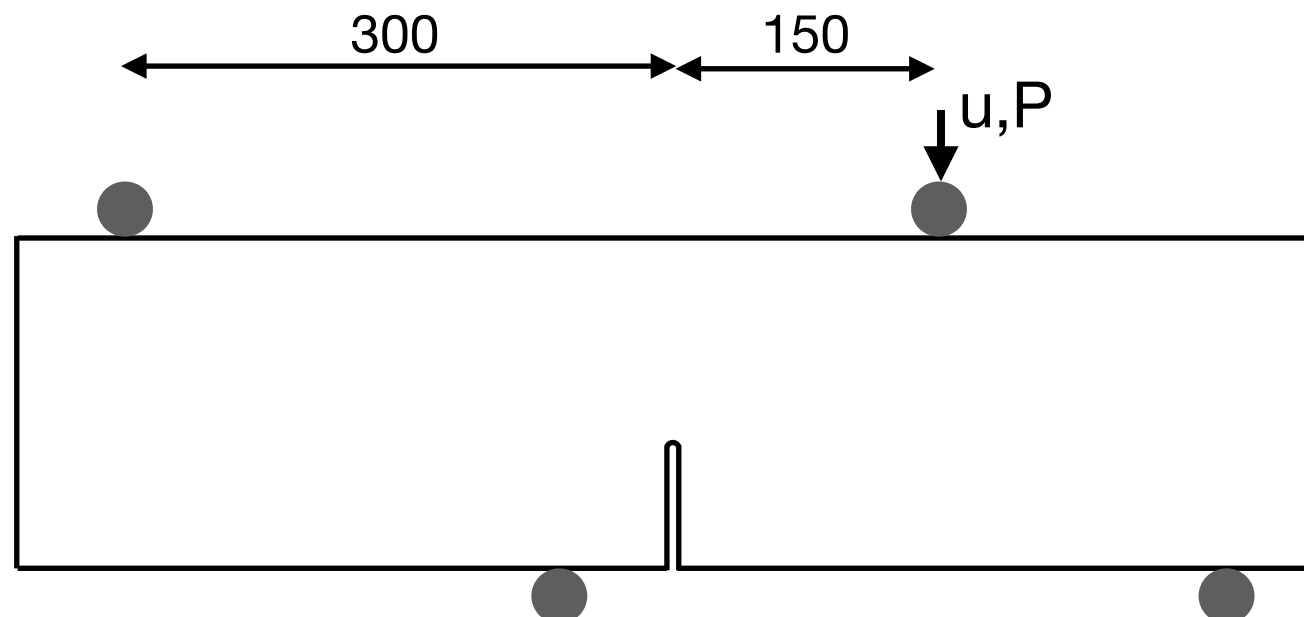
Reported crack paths
(Galvez et al,1998)

Three-point bend:
Crack paths — Expt. and Simulation

Four-point bend:
Crack paths — Expt. and Simulation