



Schenectady T2 tanker failure 1943

The *Schenectady* fractured at dock within a day of launching



World concord, 1954



U.S.S. Esso Manhattan



Catastrophic Damage During World War II



5000 ships built

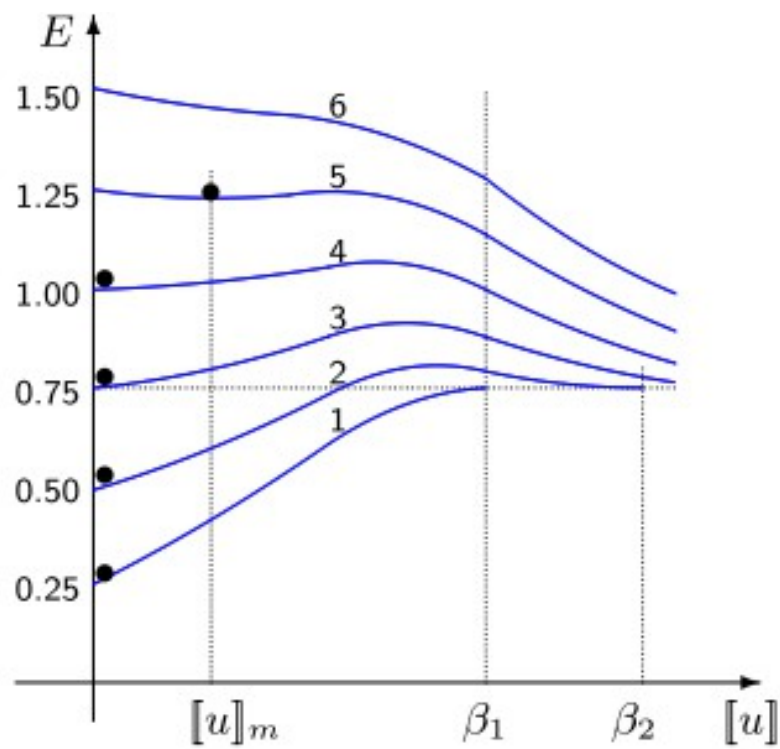
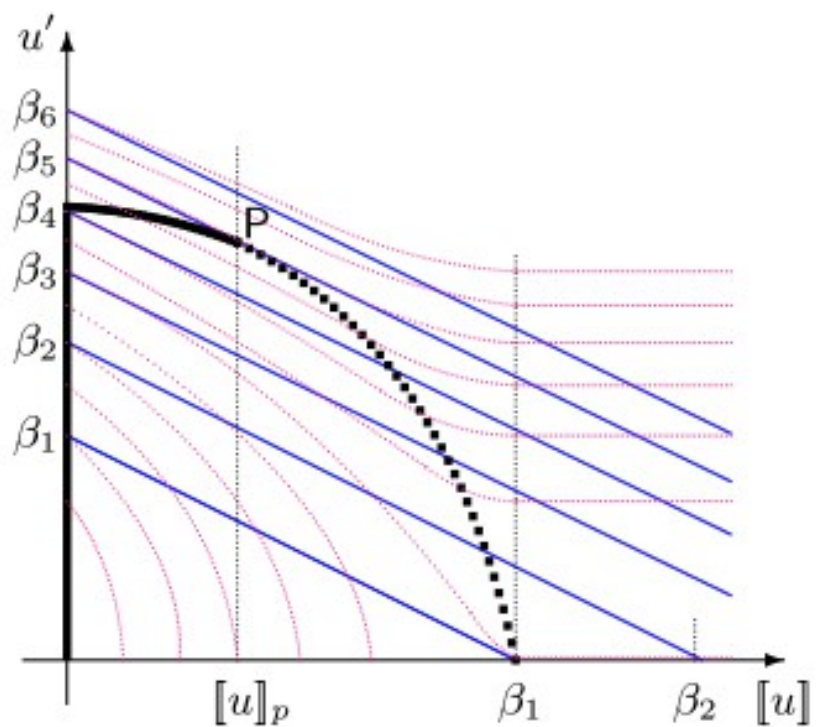
over 1000 ships: cracks by 1946

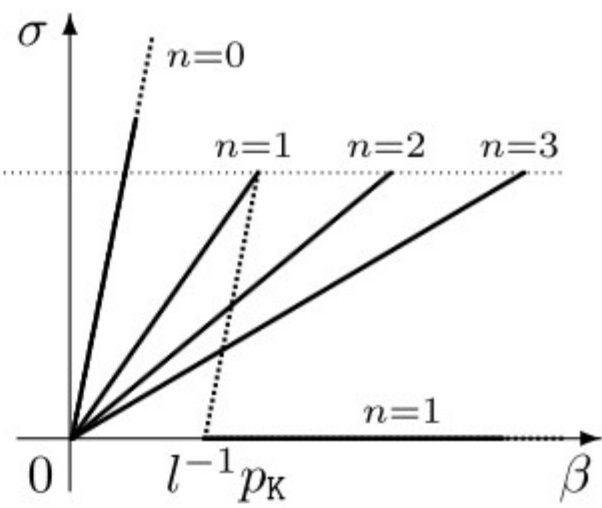
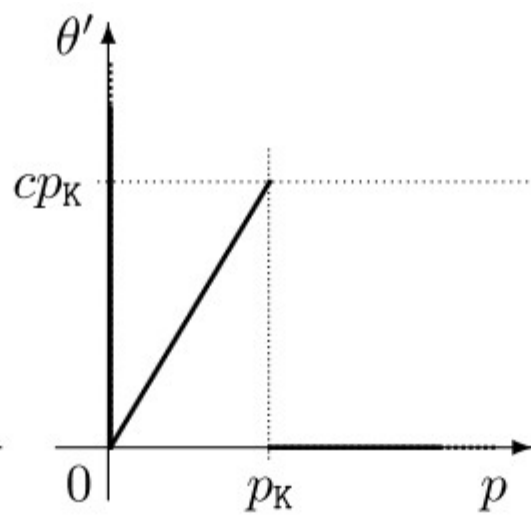
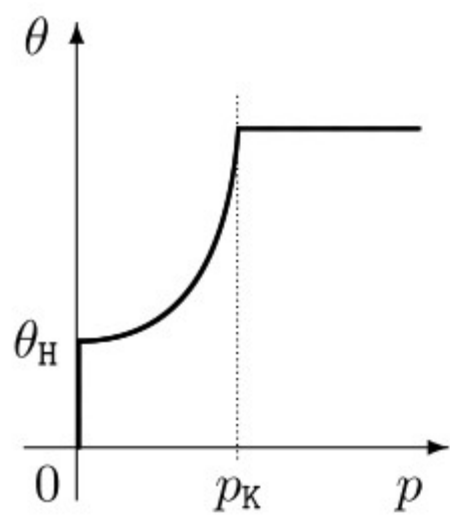
200 ships: serious damage

9 T-2 tankers

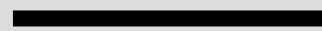
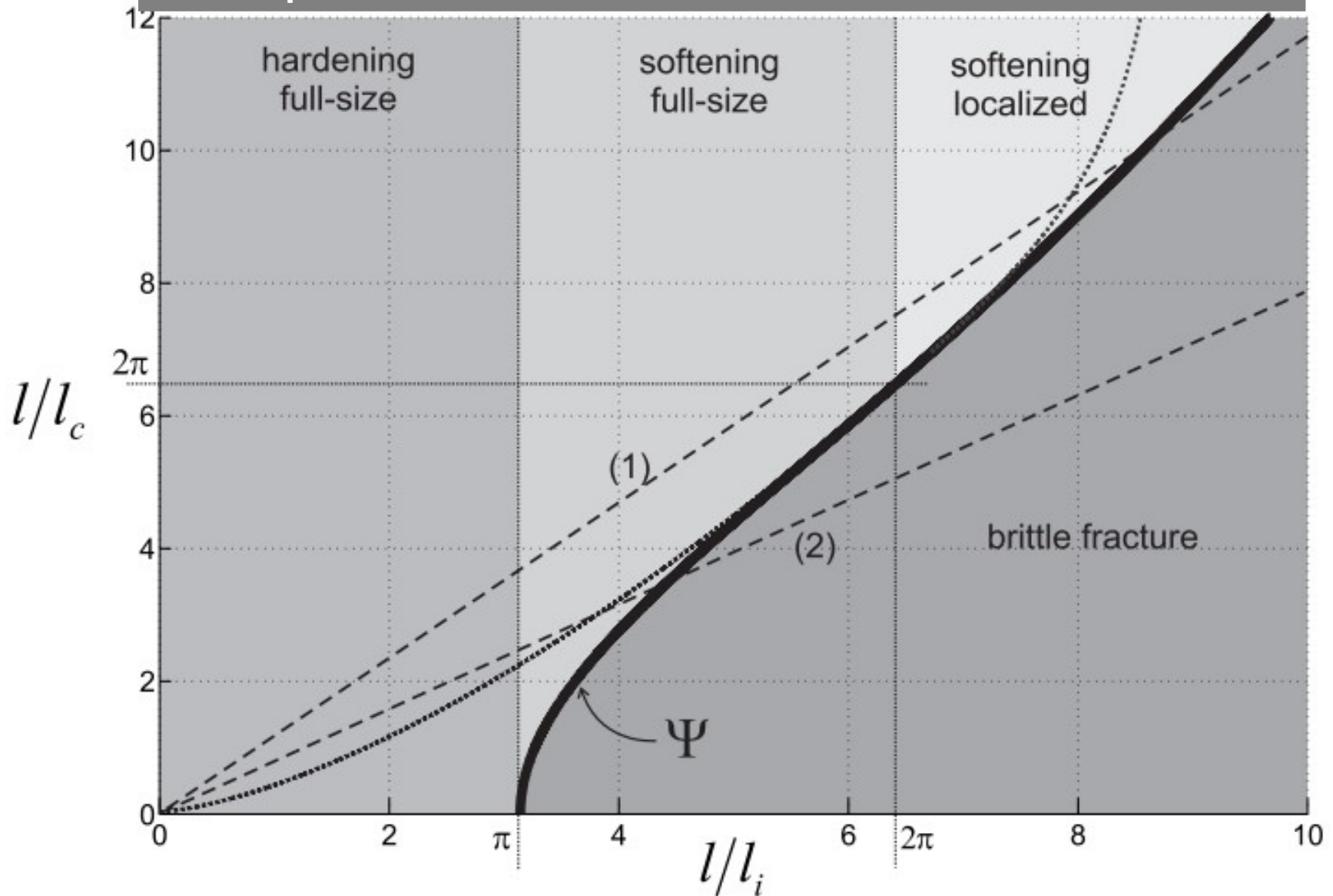
7 Liberty ships

broken in two





the response at the onset of the inelastic deformation for $\theta'' < 0$

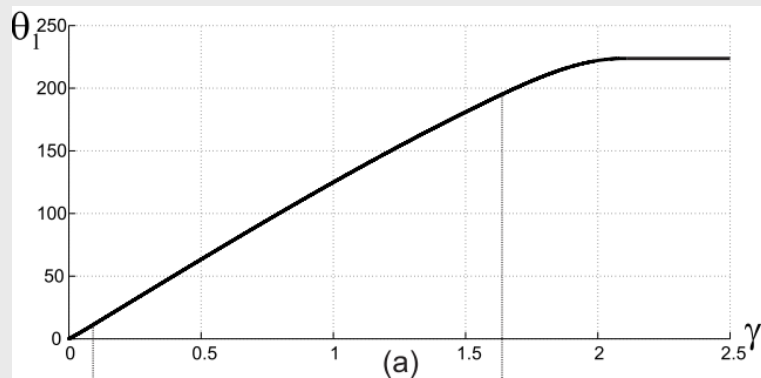
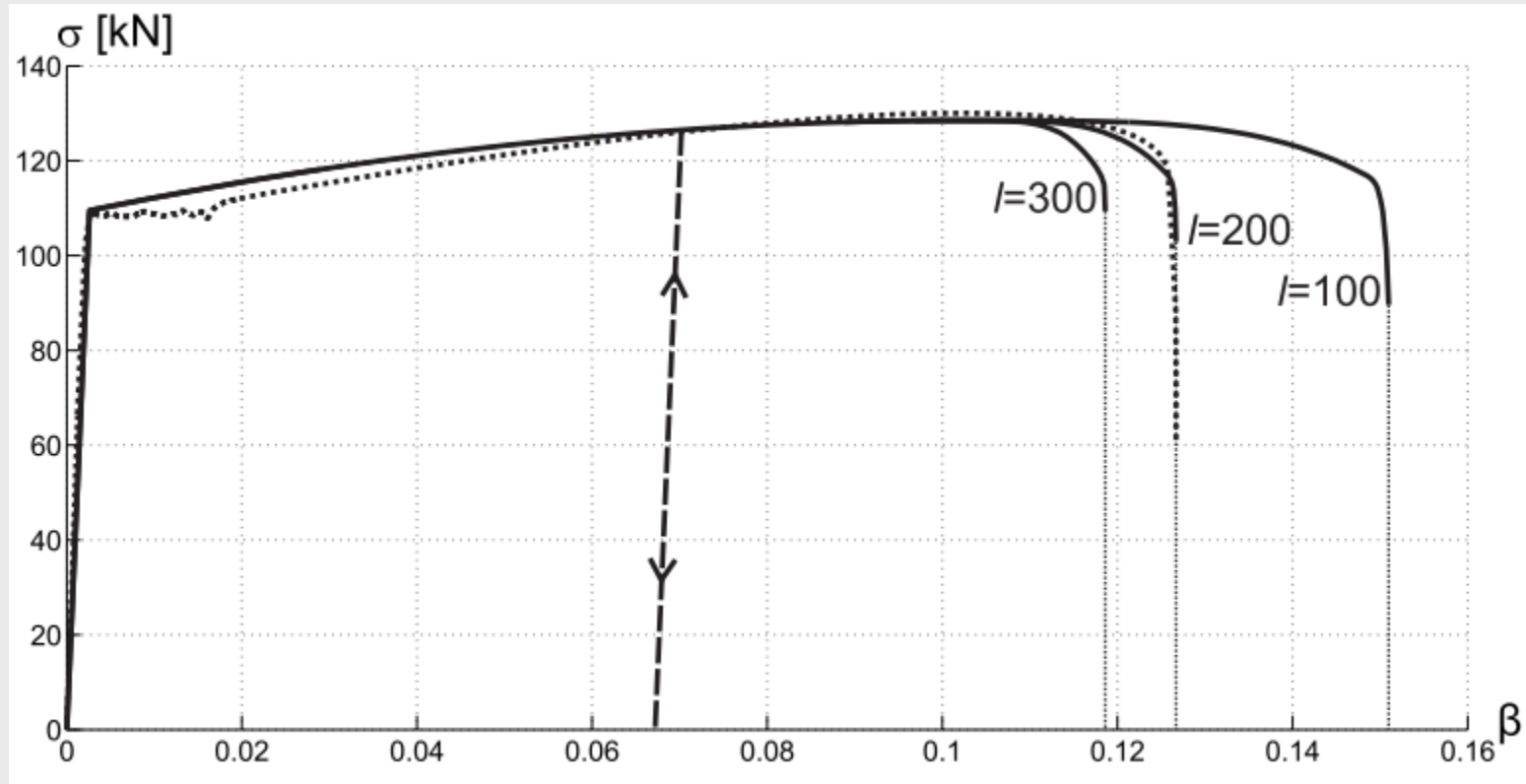


limit of brittle fracture

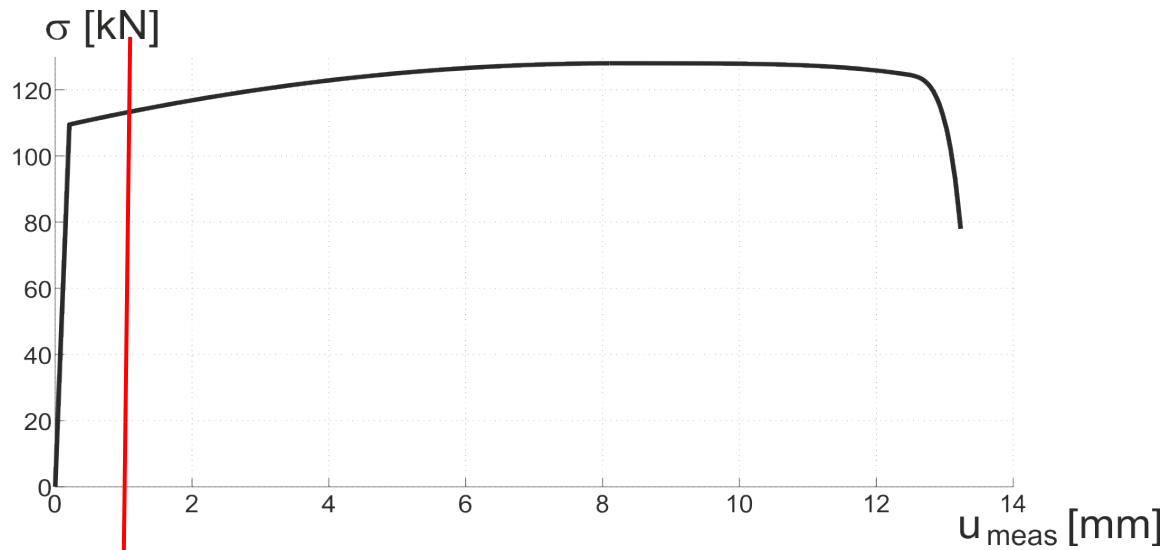


bars made of the same material

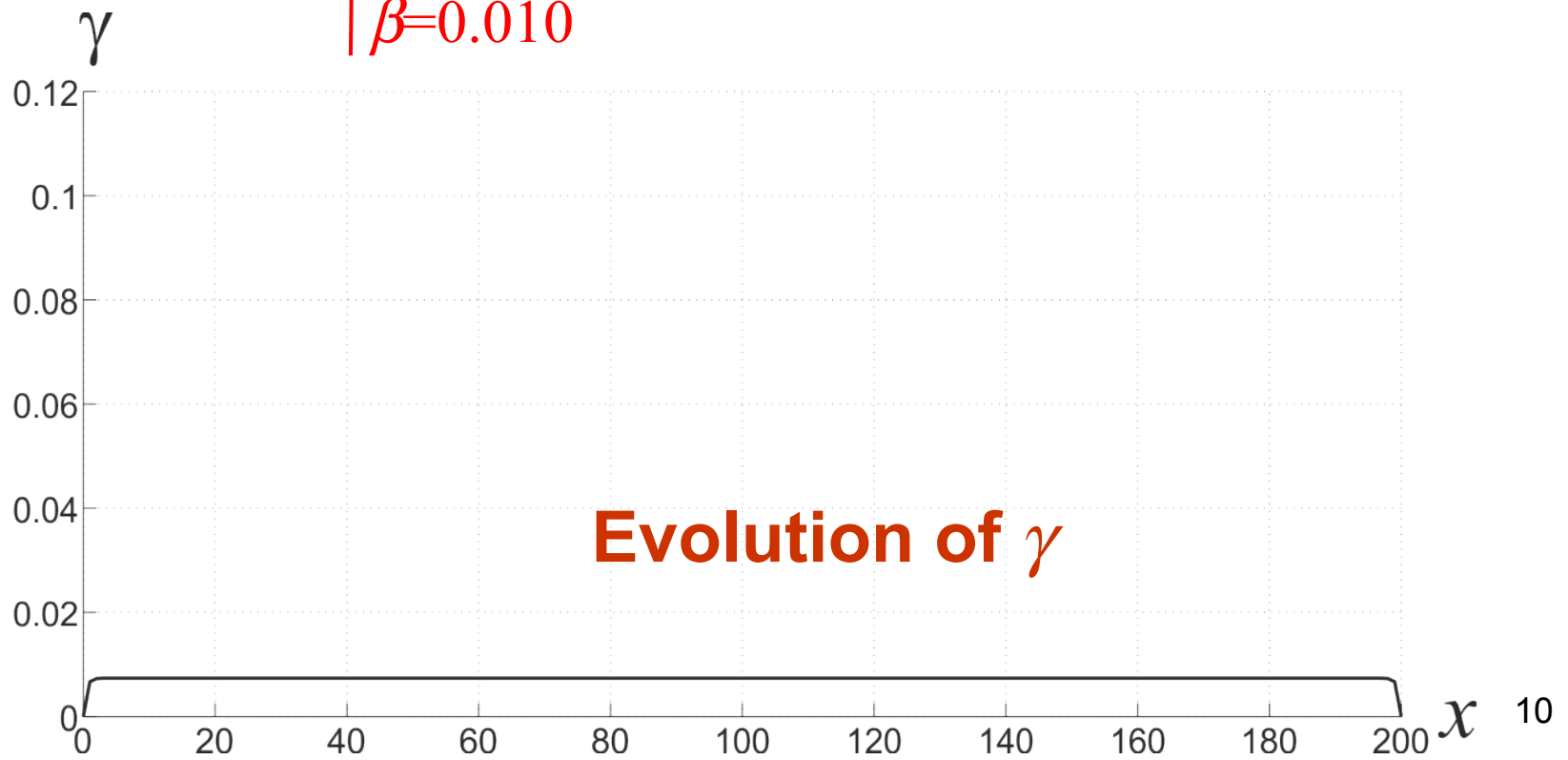
response curve of a steel bar

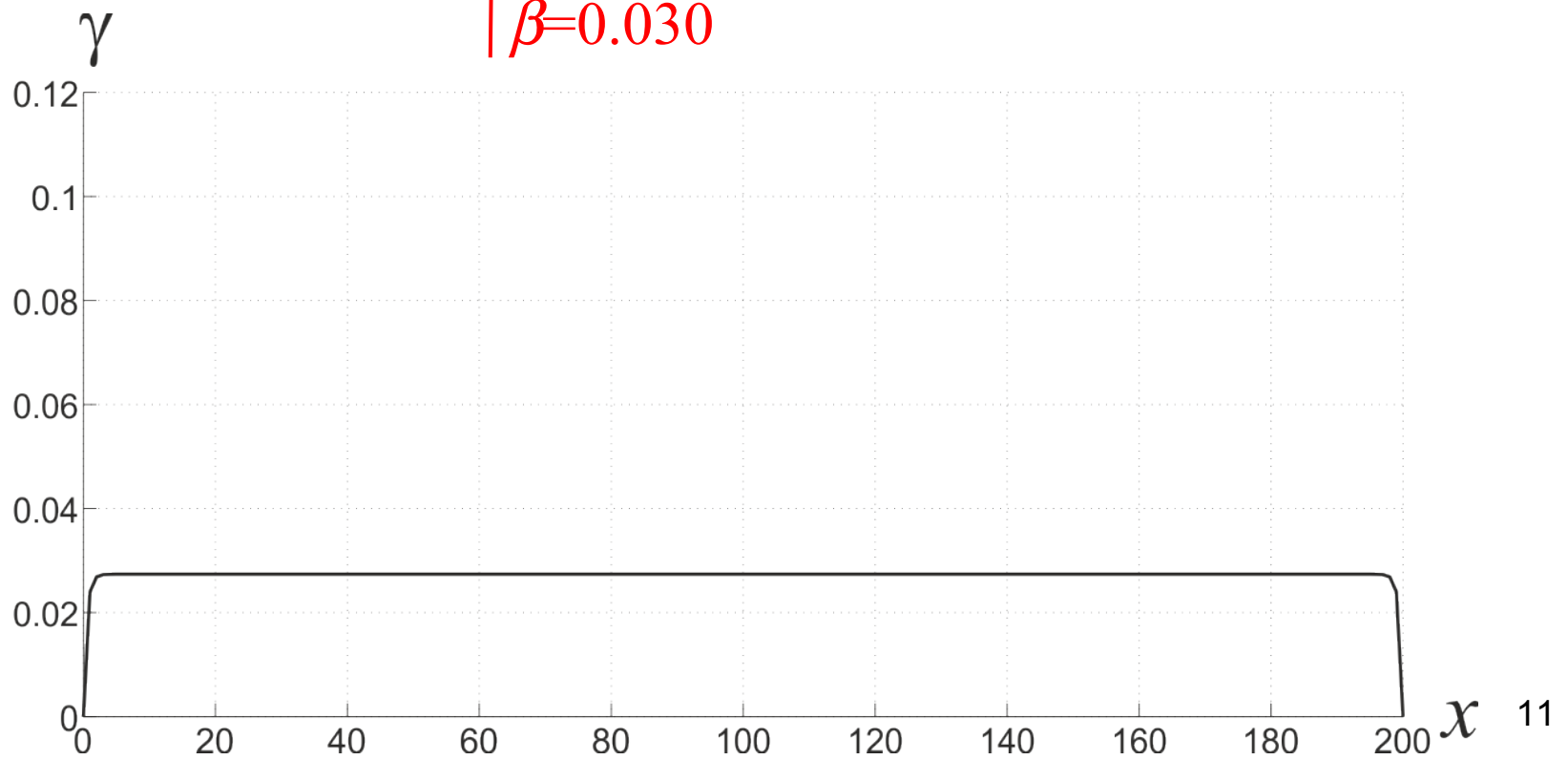
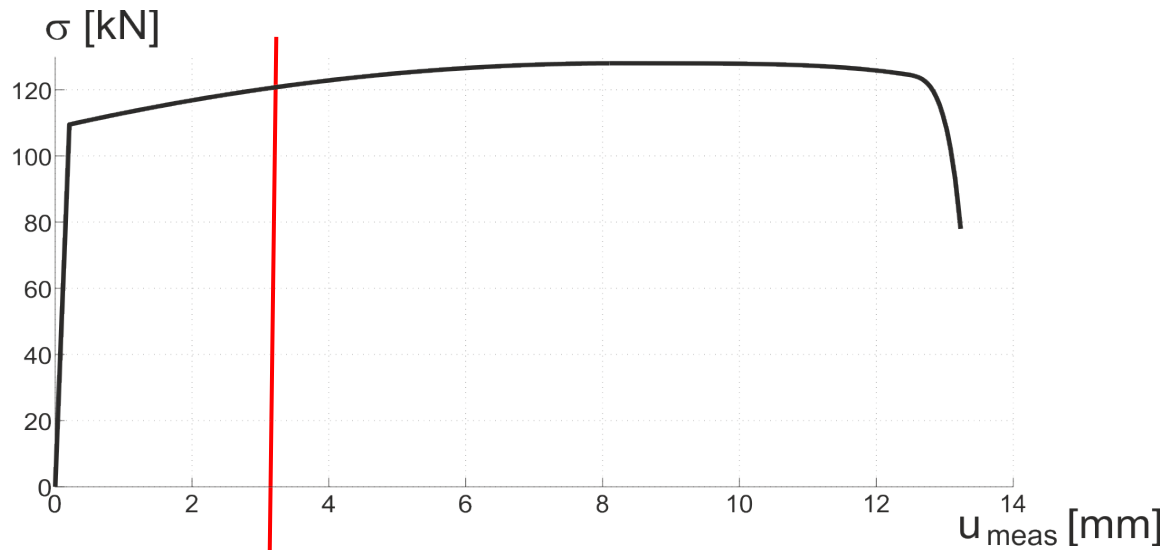


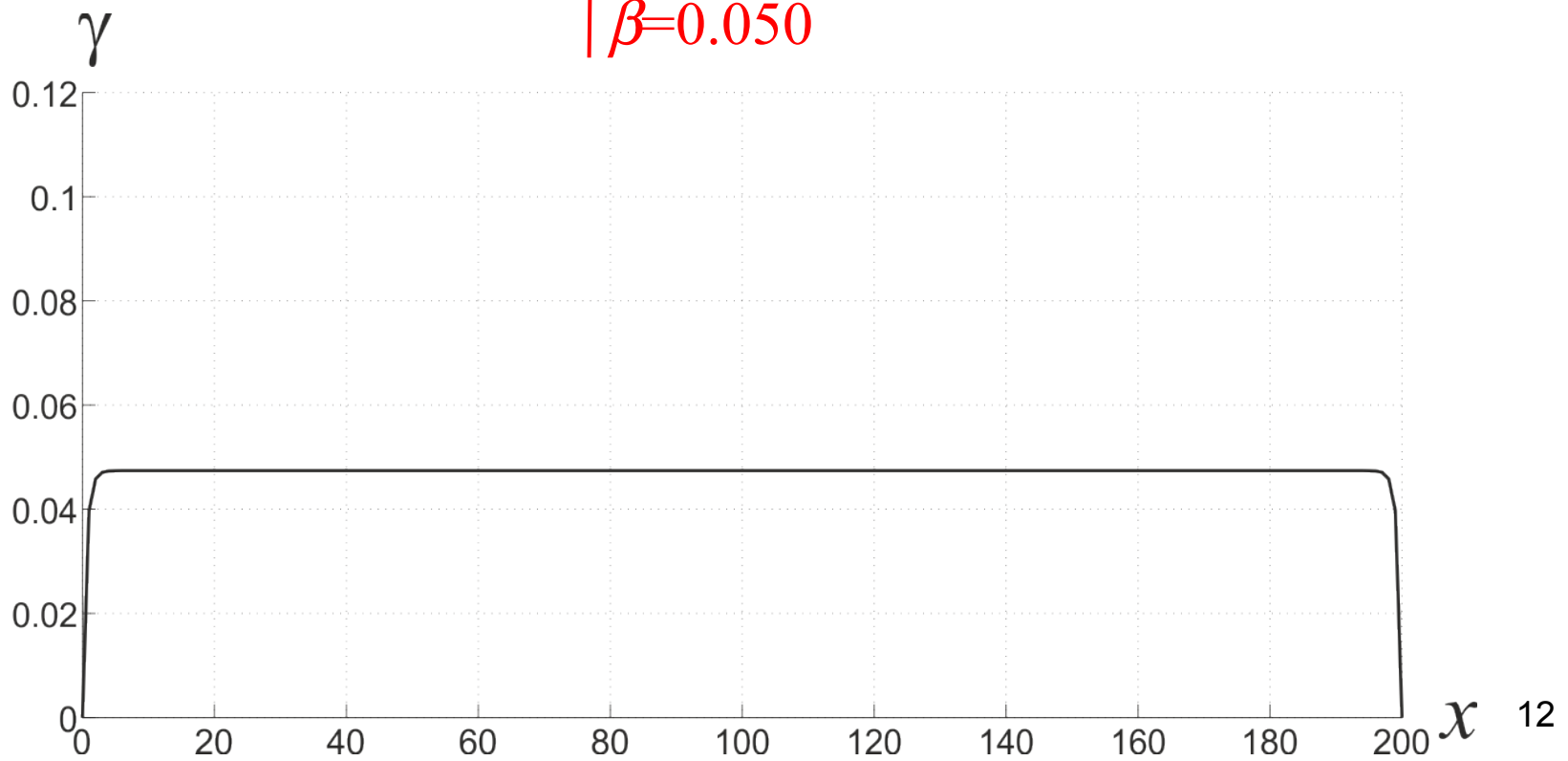
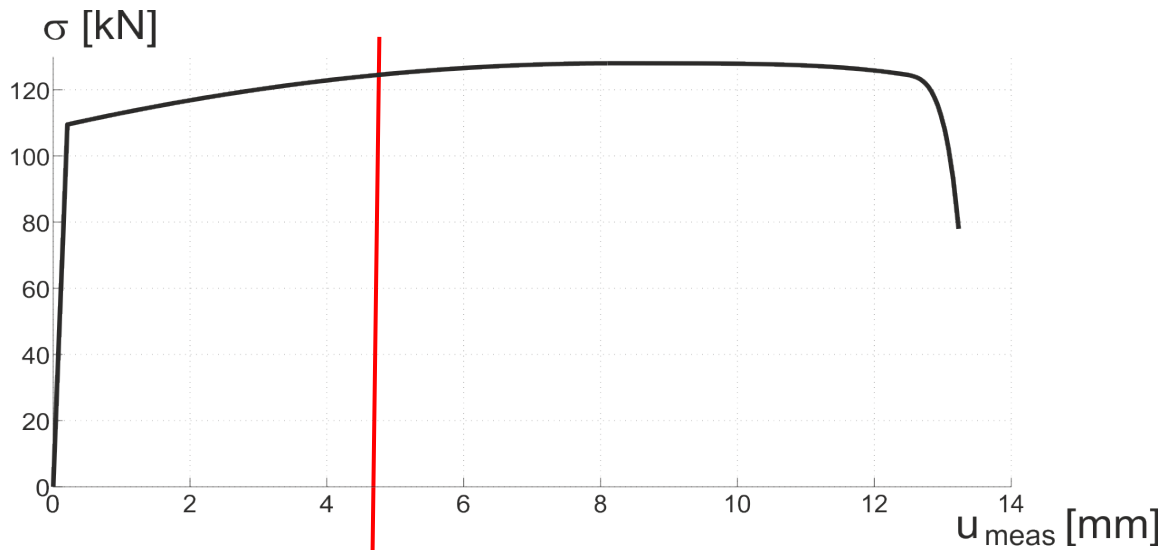
convex-concave cohesive energy
4 material constants

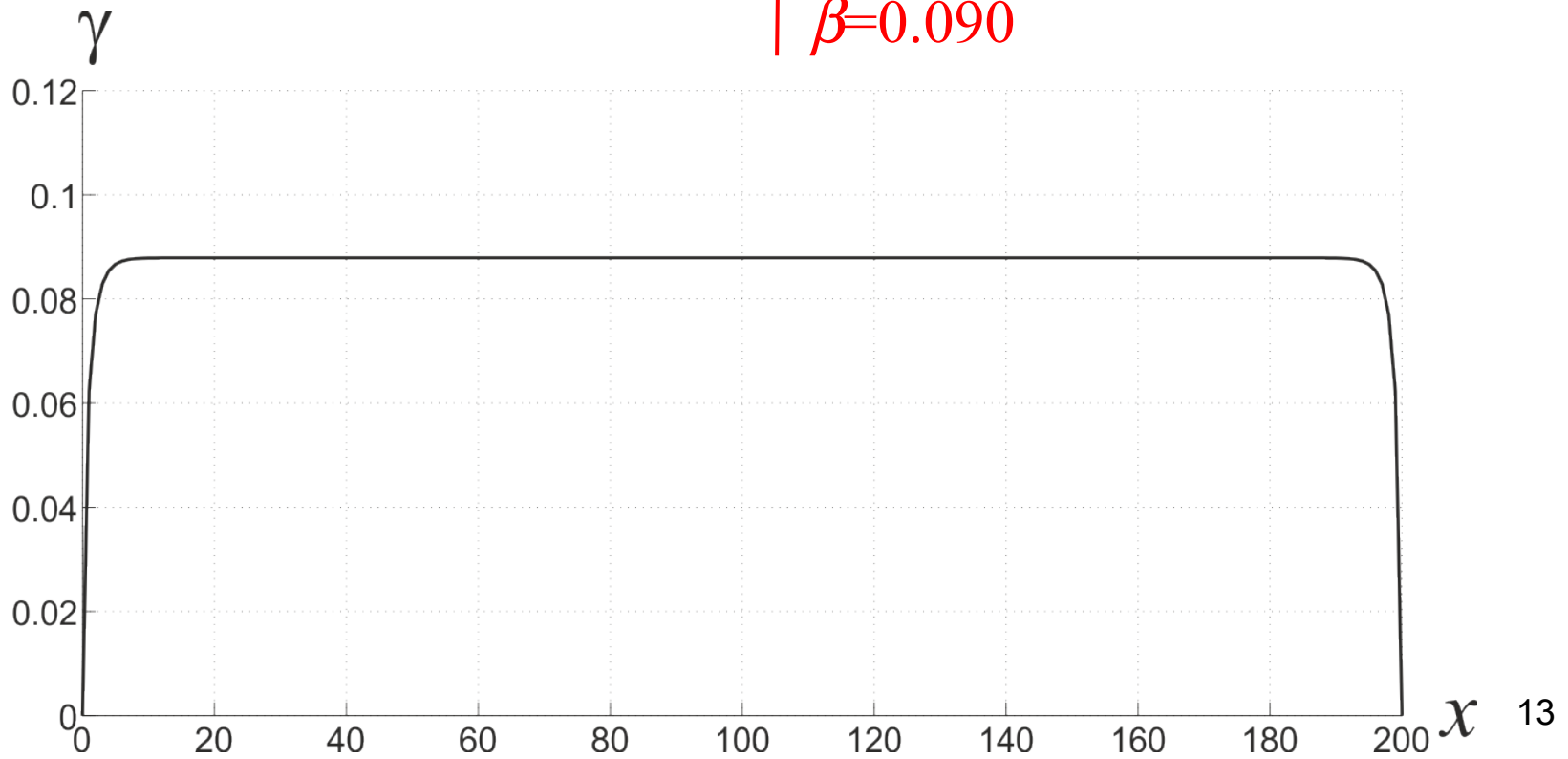
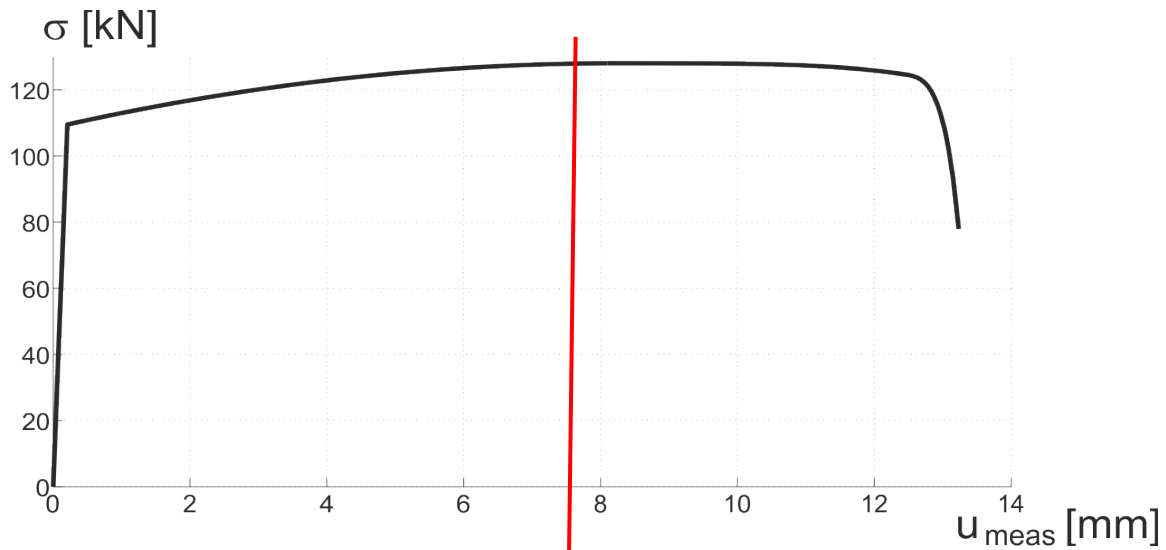


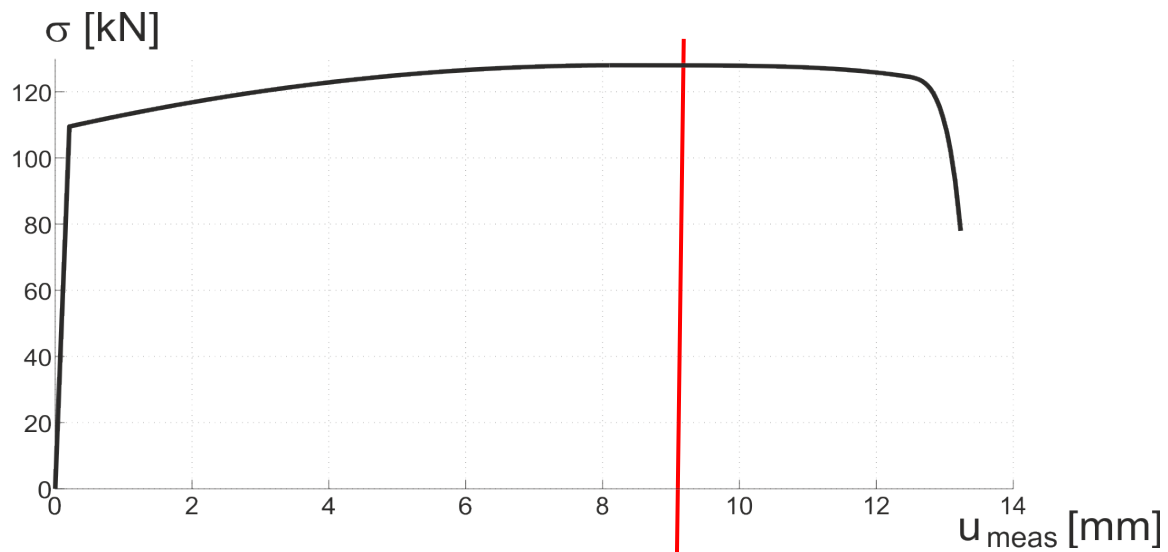
$\beta=0.010$



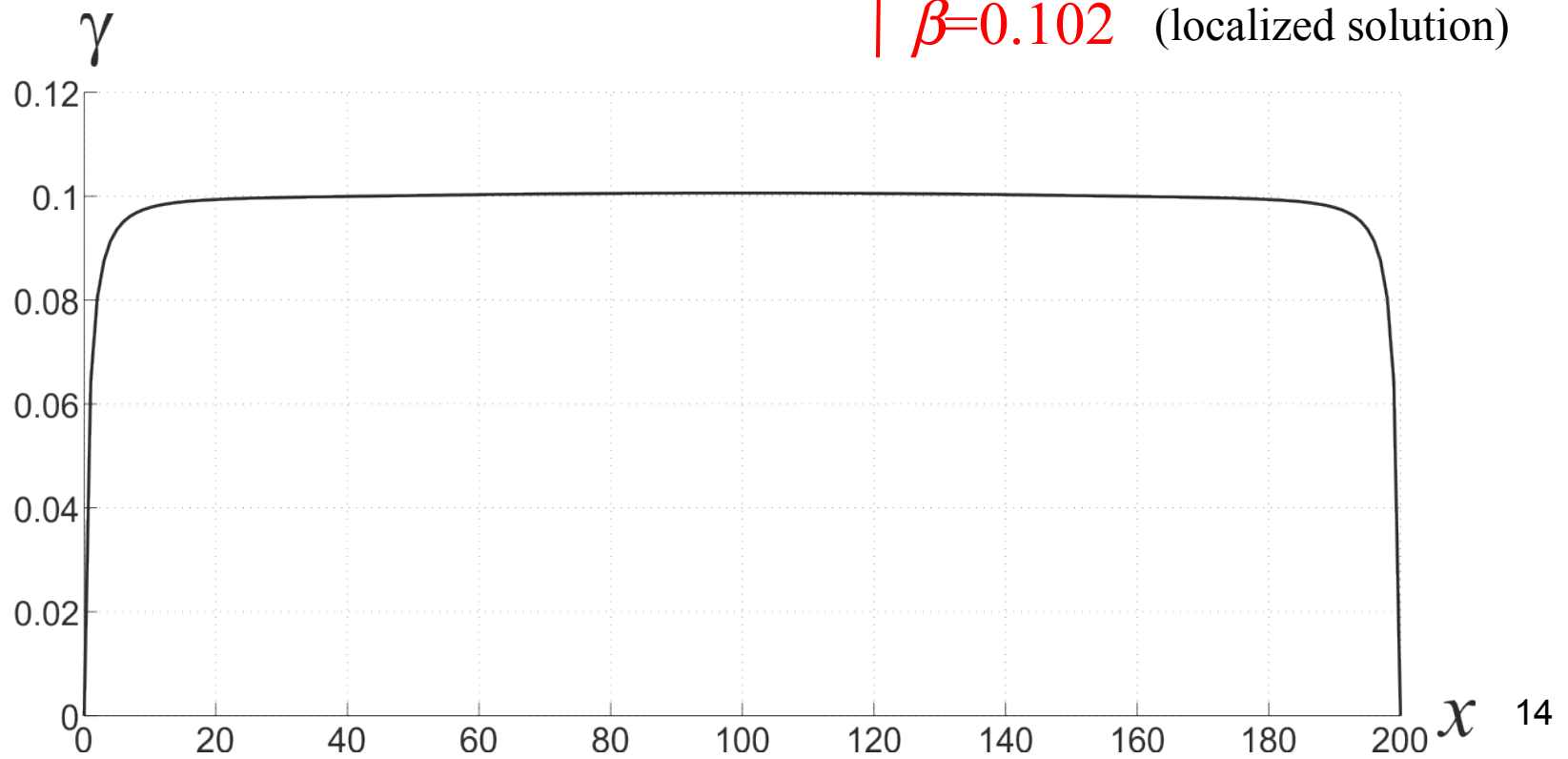


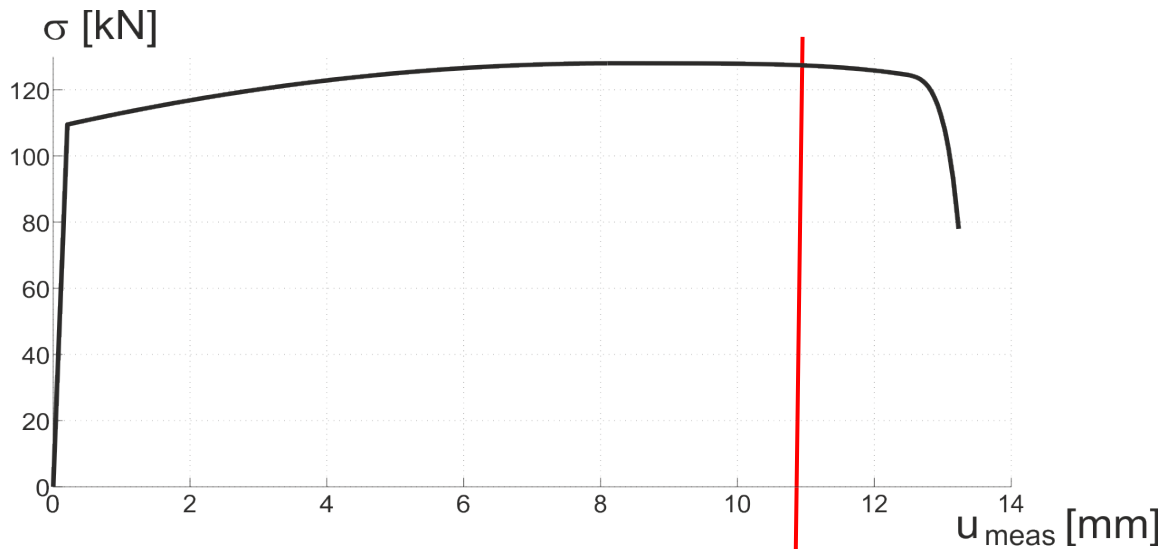




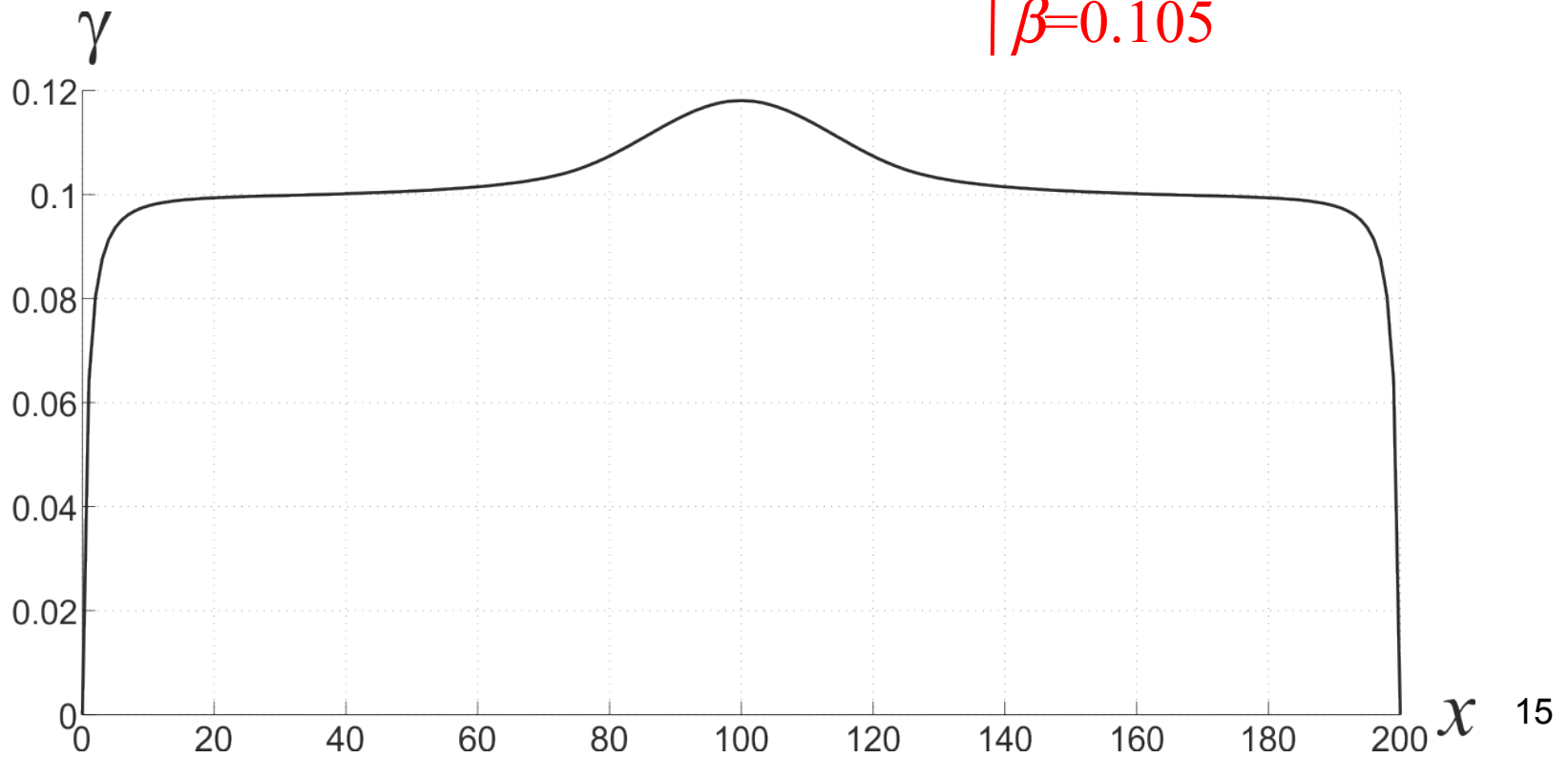


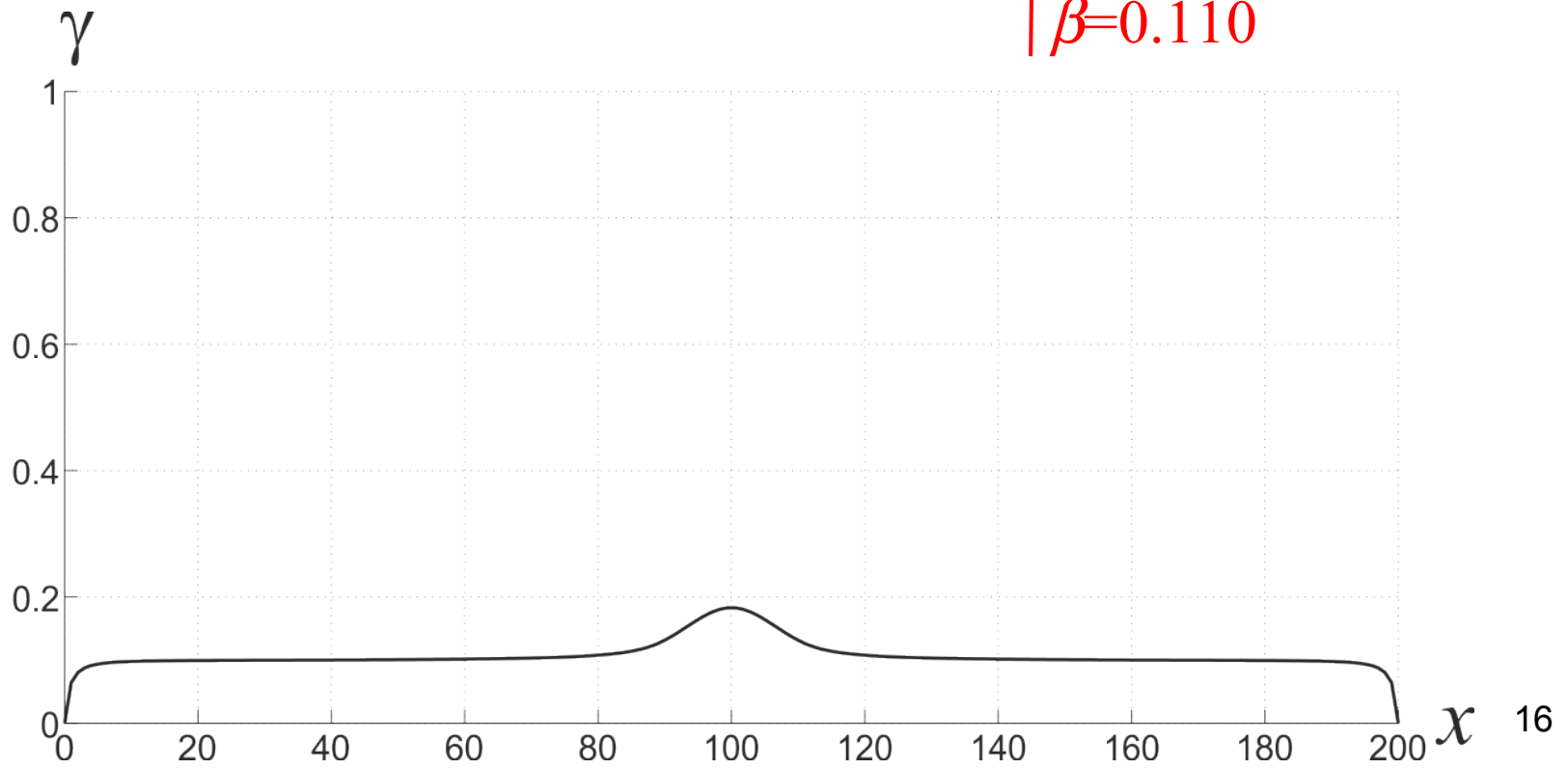
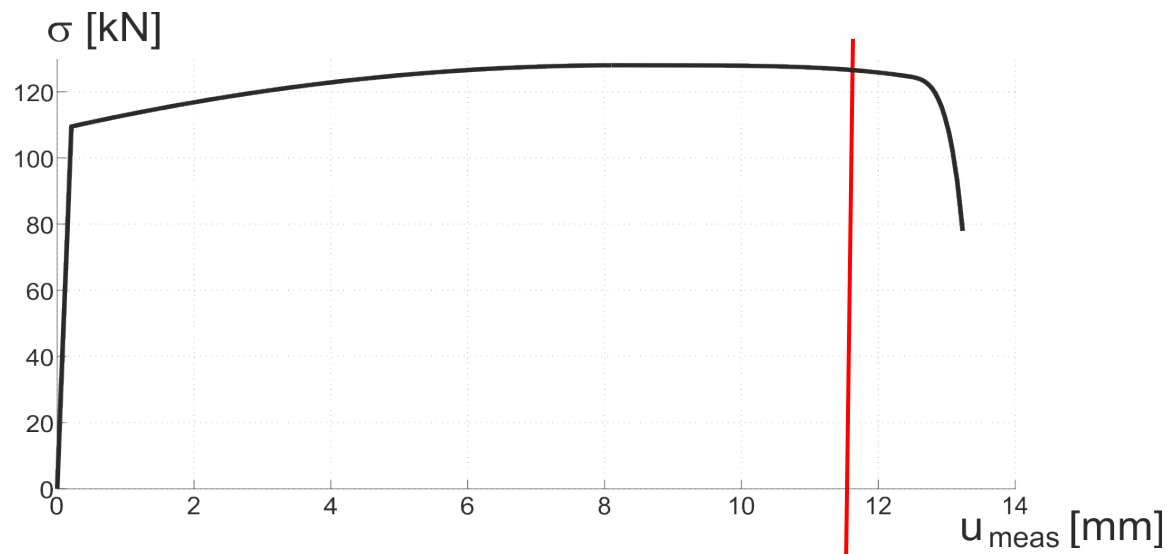
$\beta=0.102$ (localized solution)

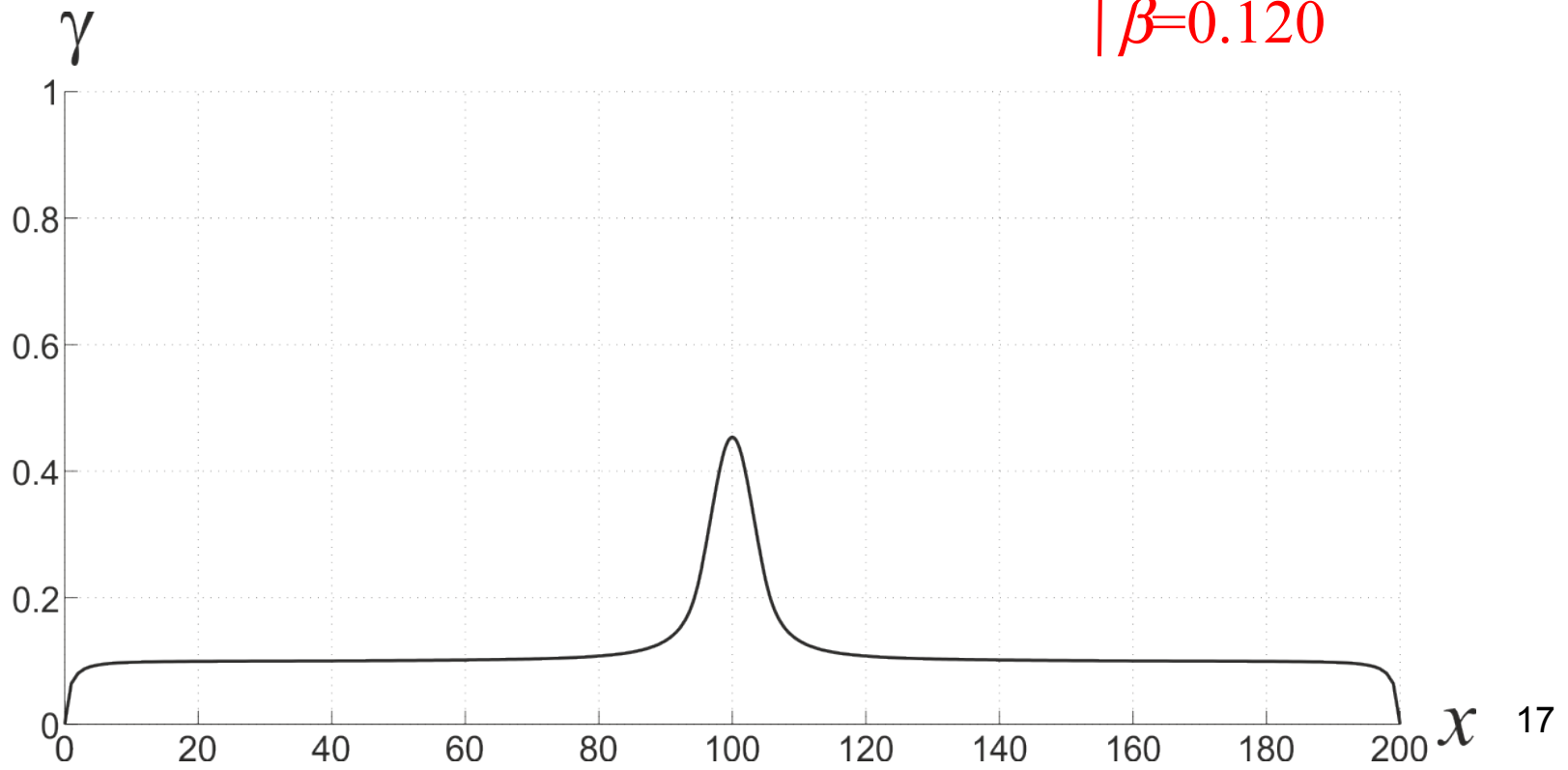
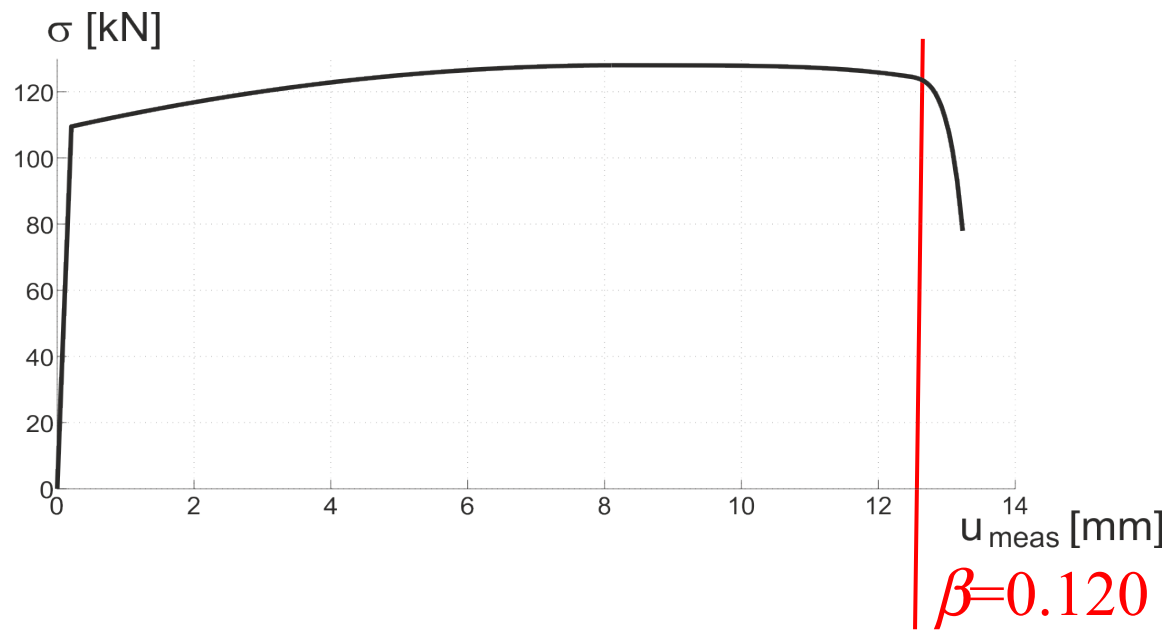


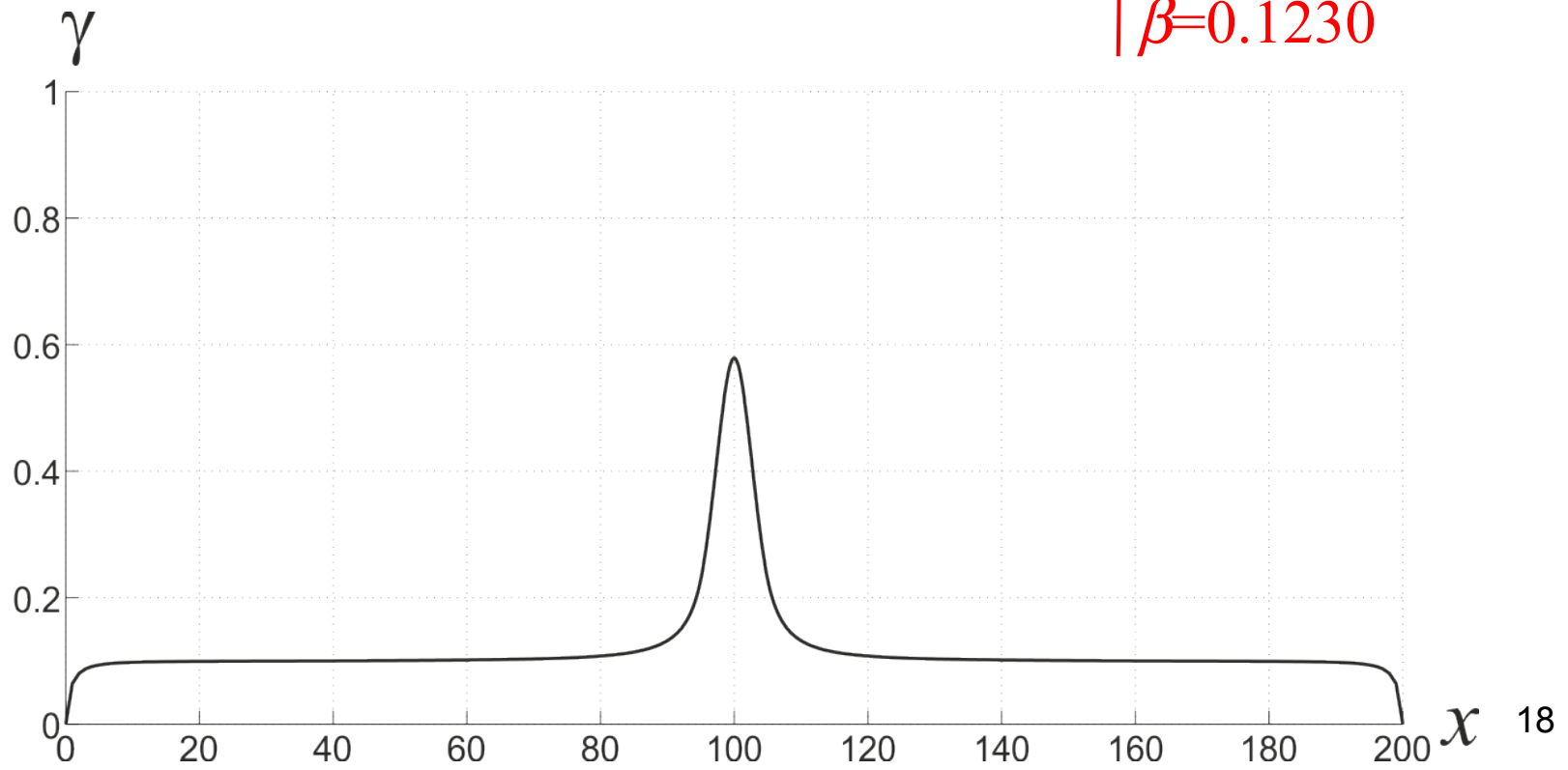
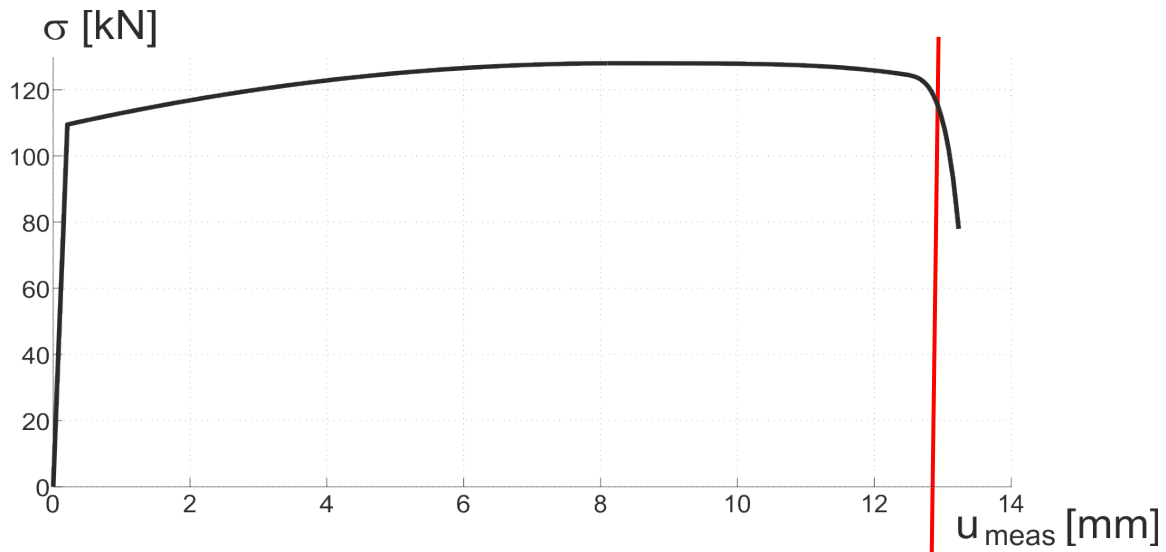


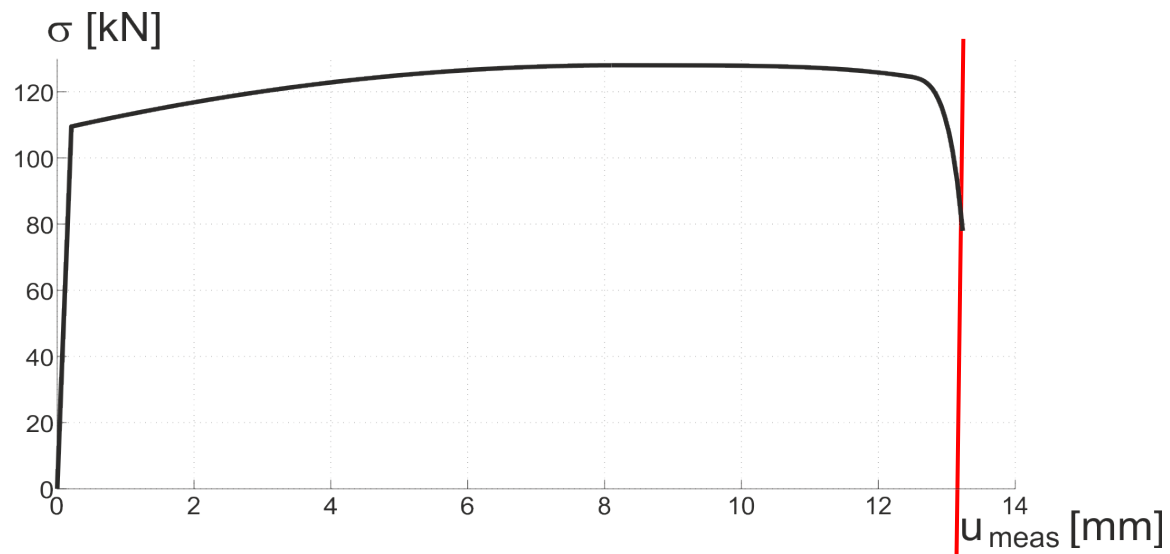
$\beta=0.105$



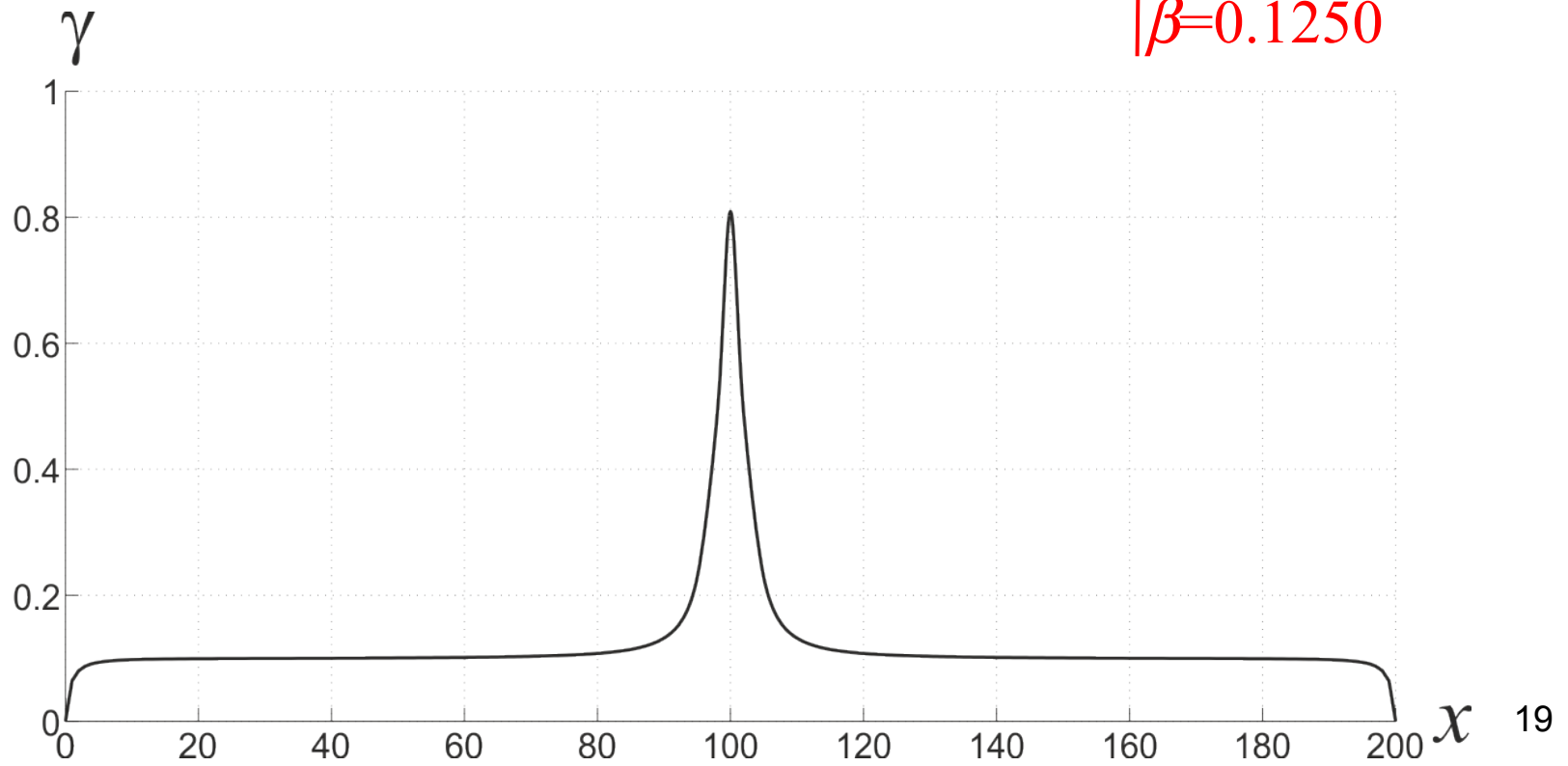


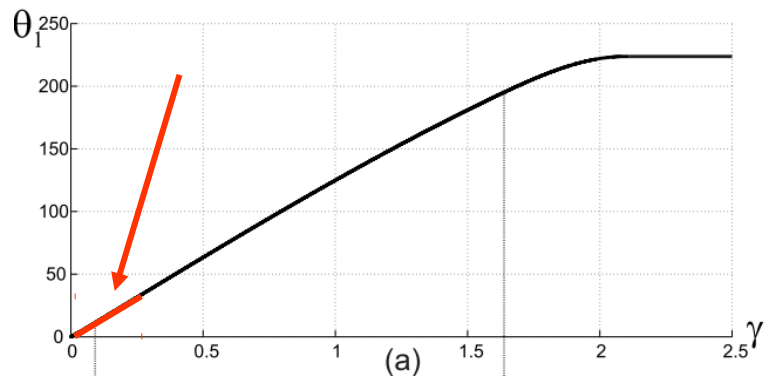
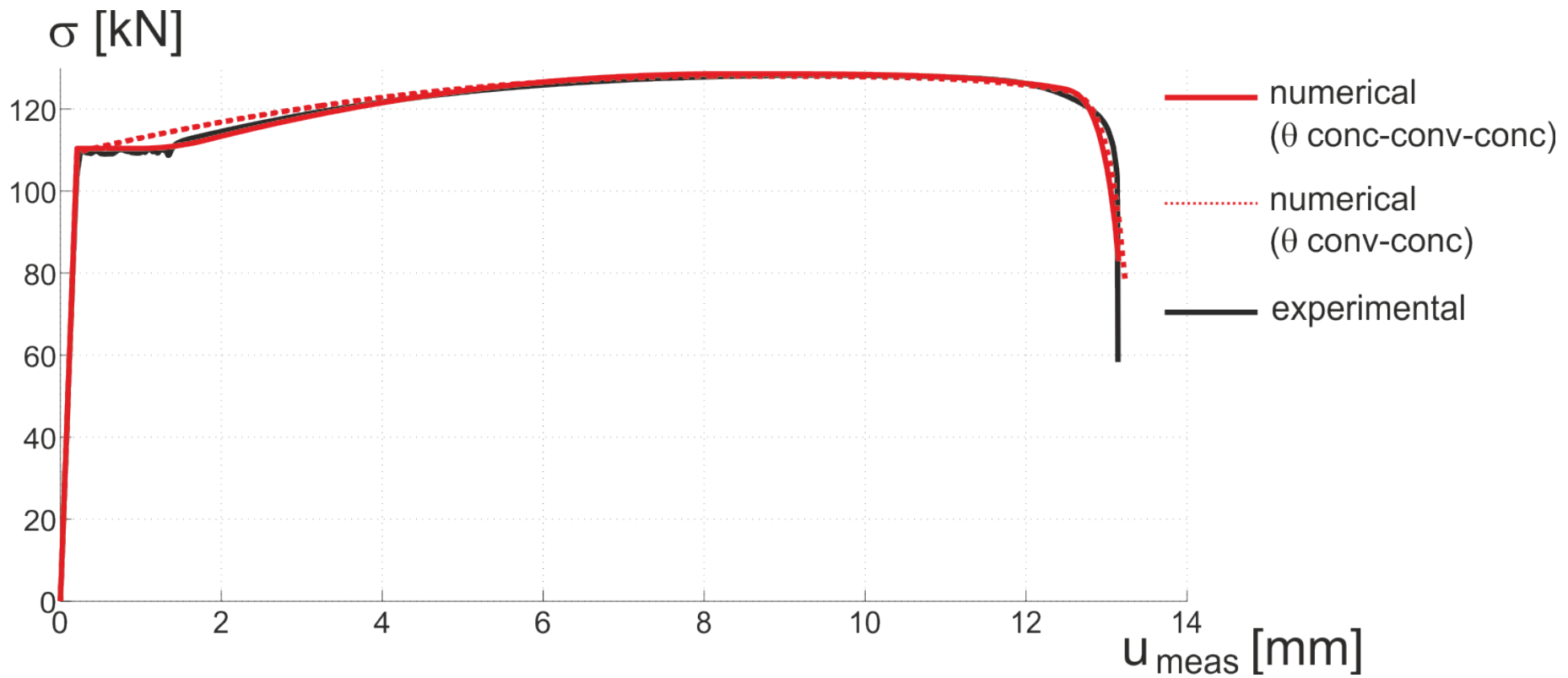




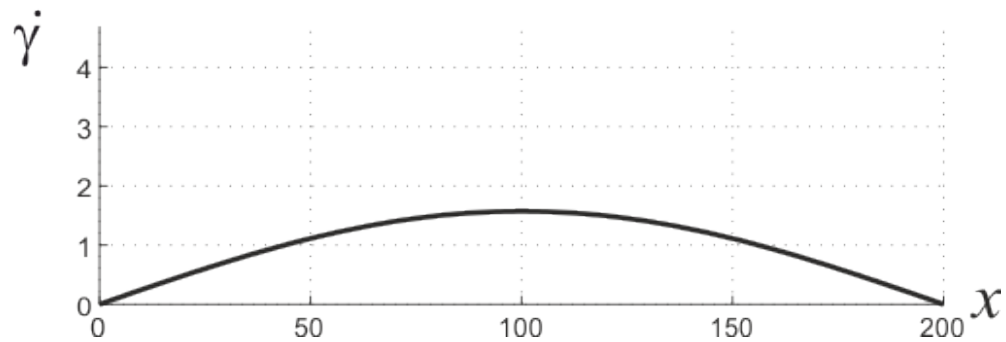
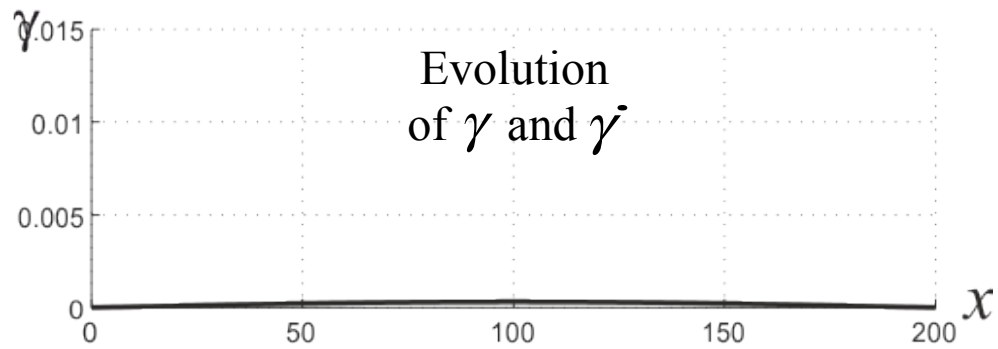
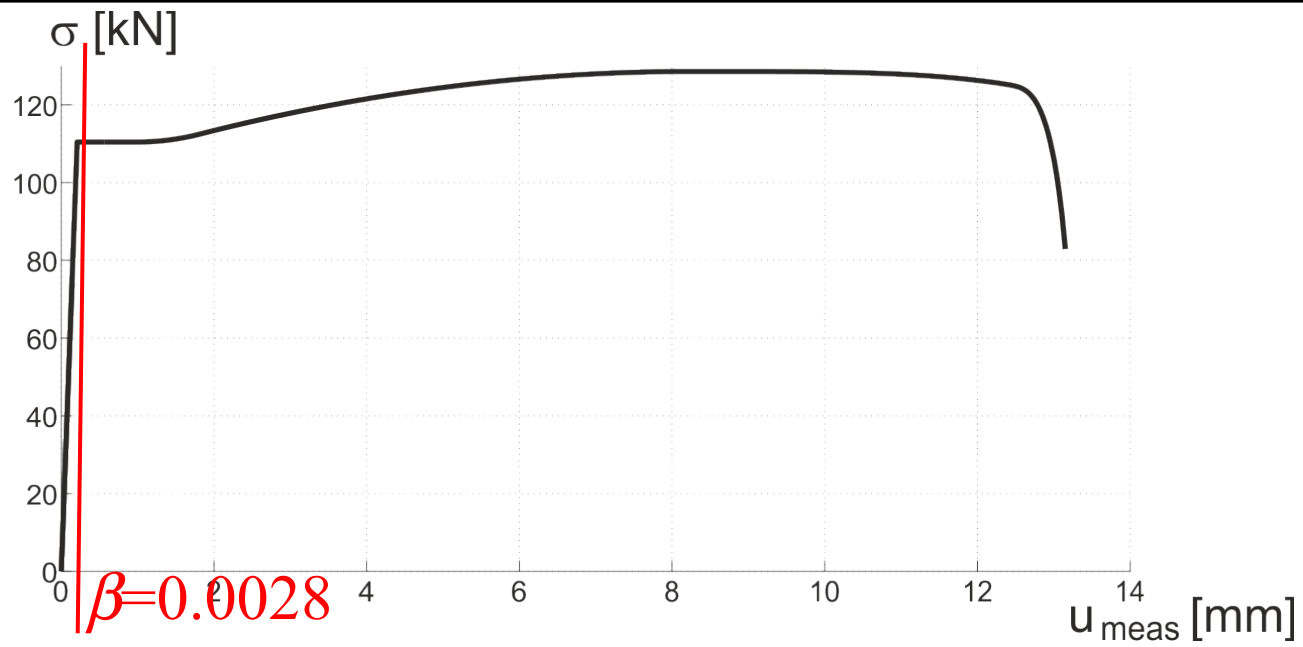


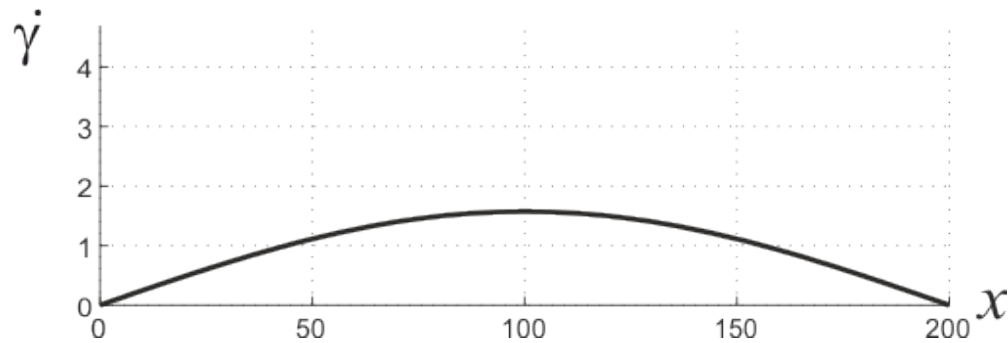
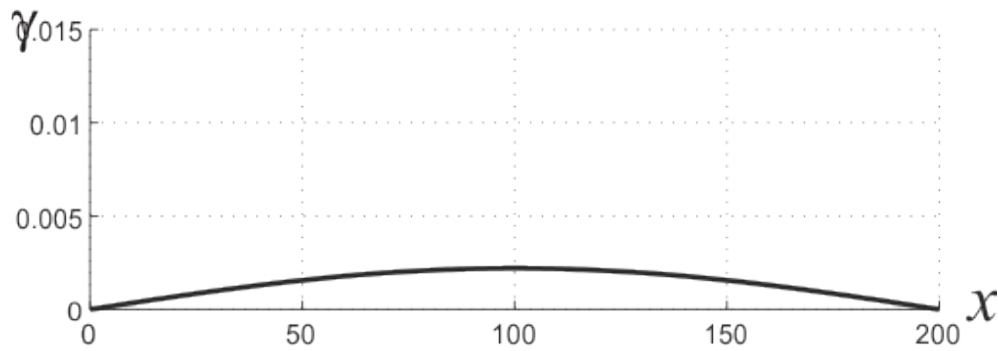
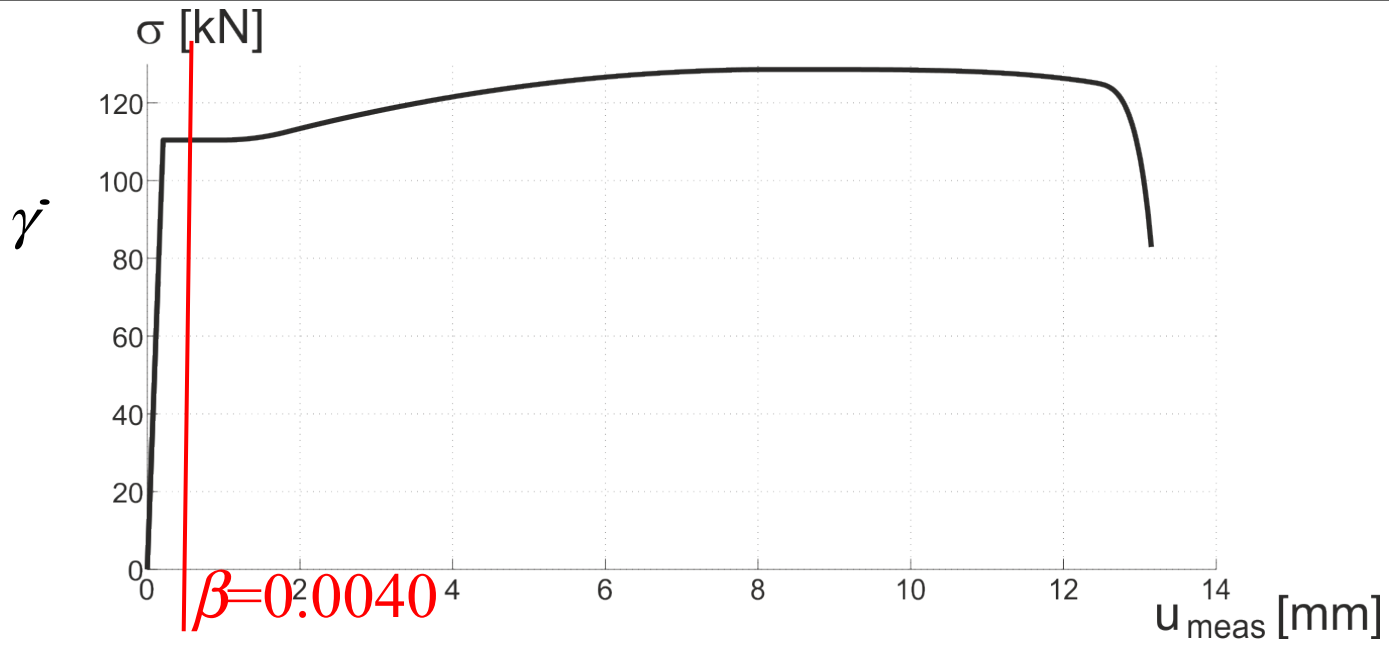
$\beta=0.1250$

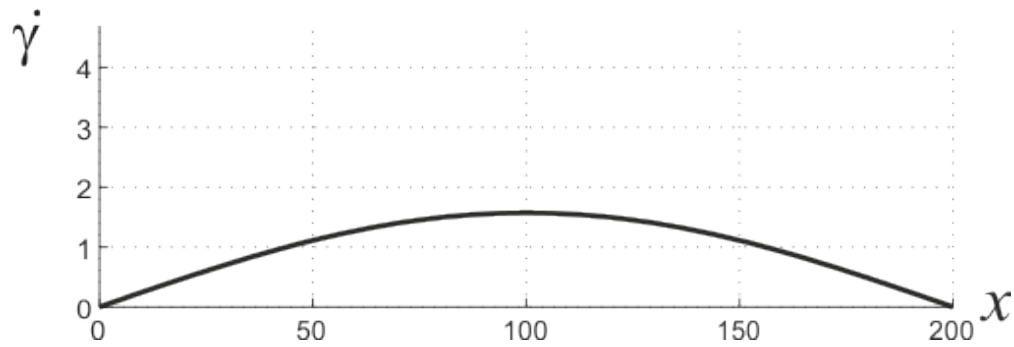
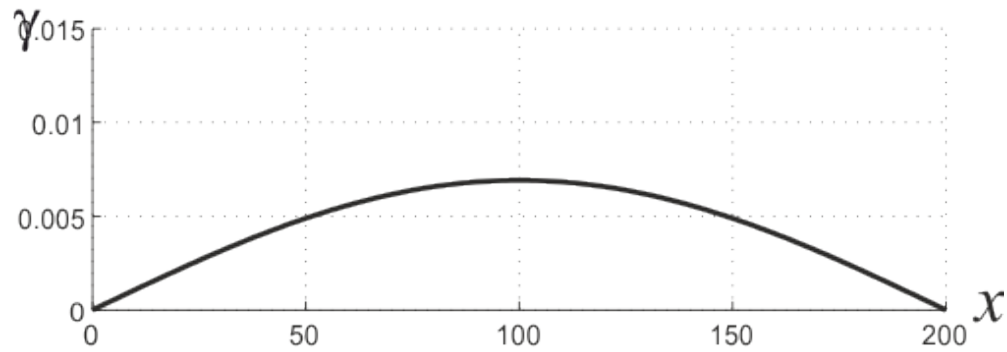
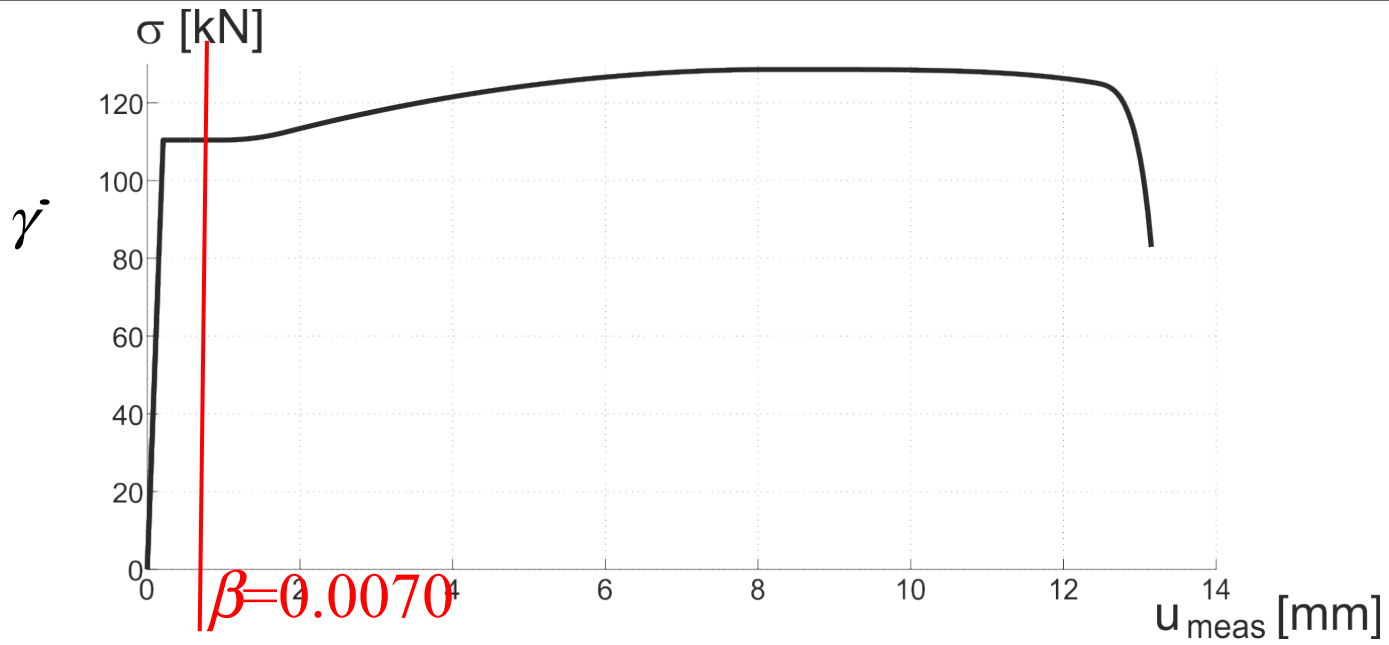


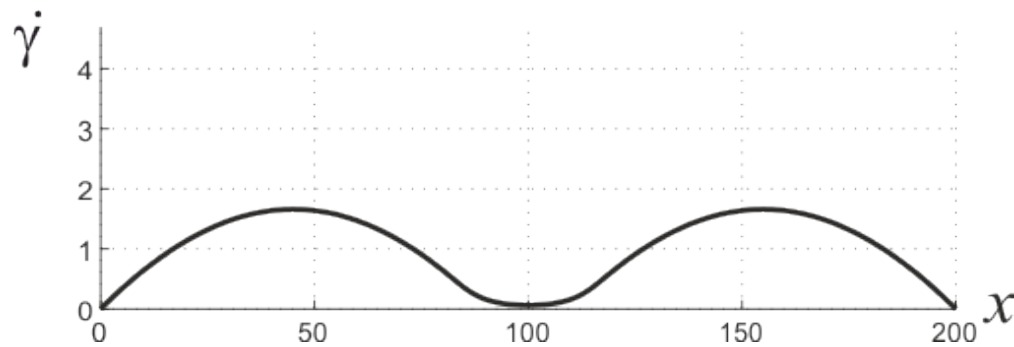
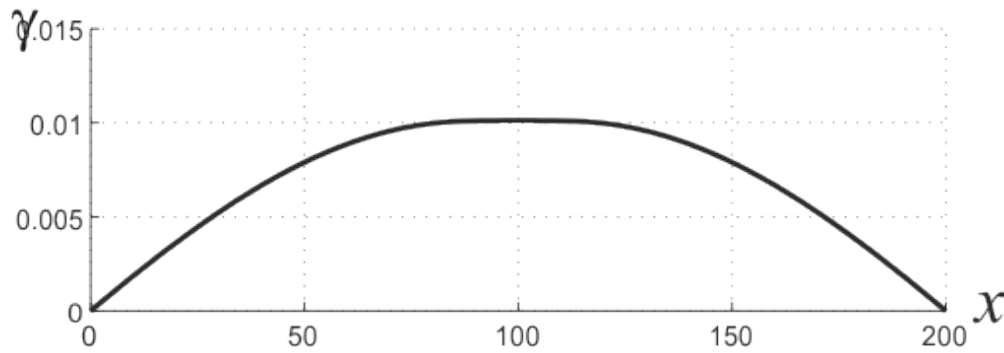
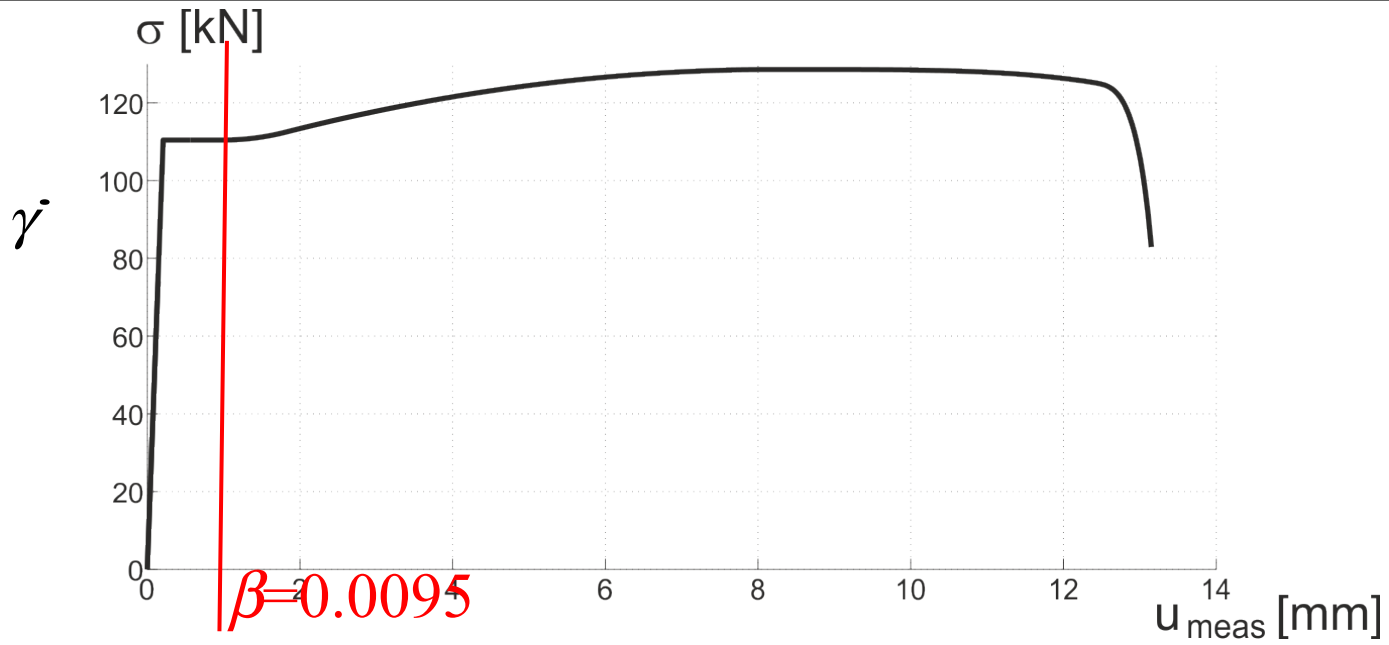


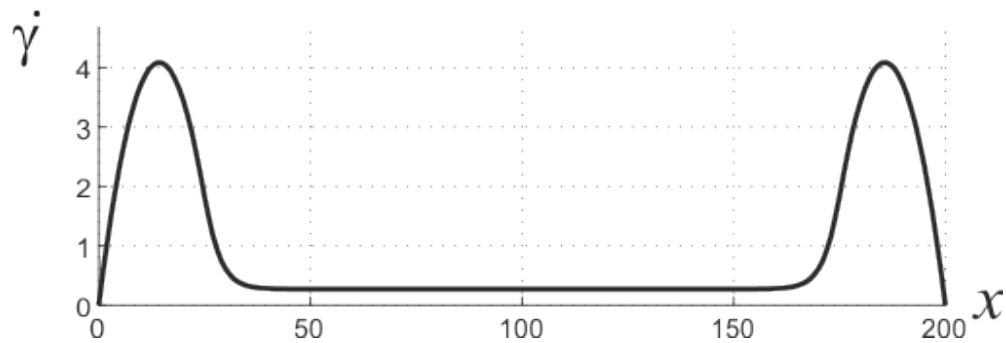
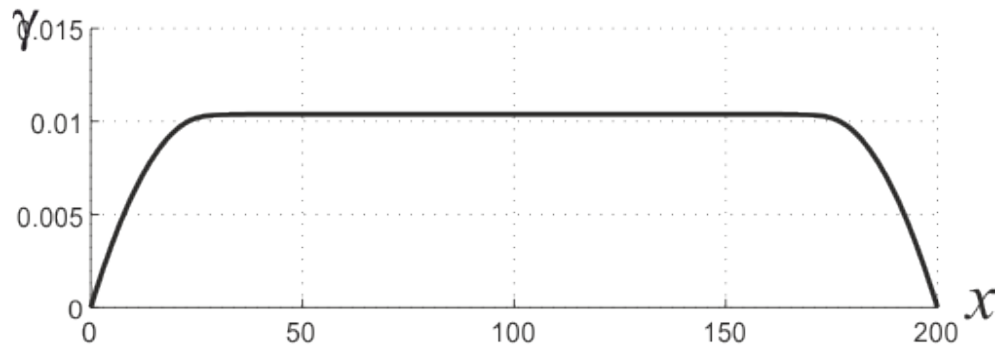
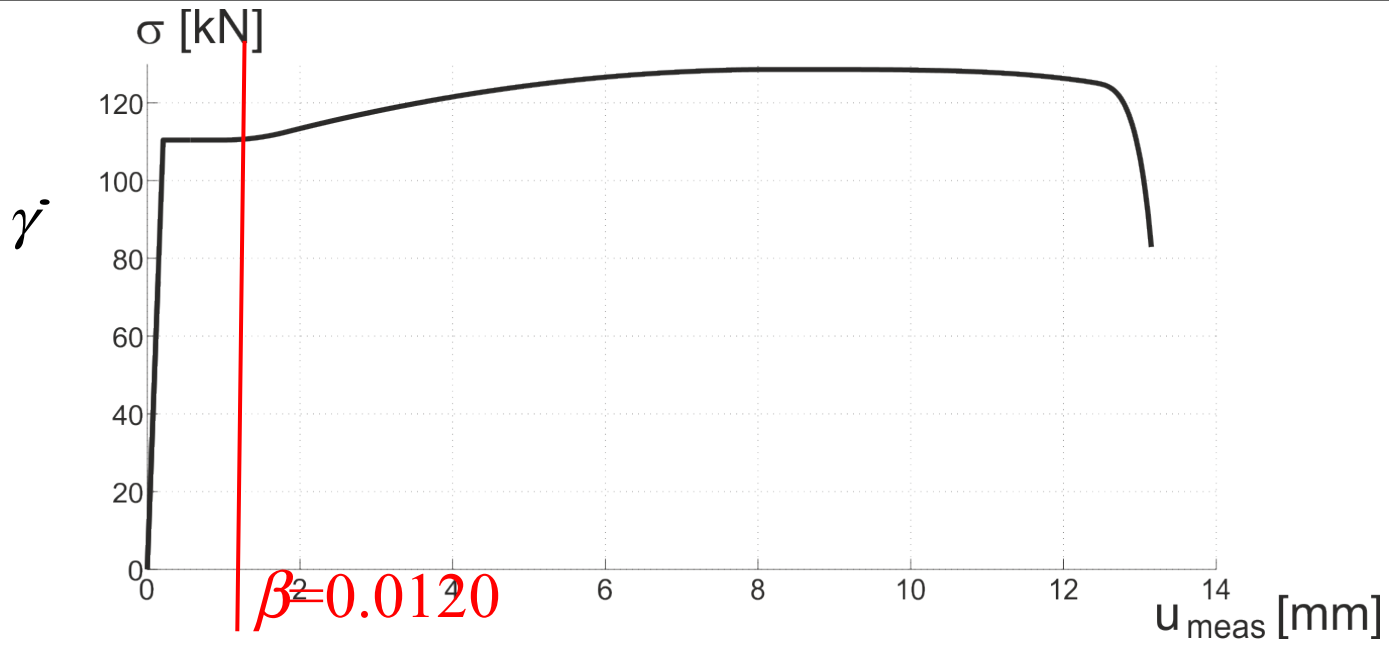
**concave-convex-concave
cohesive energy
6 material constants**

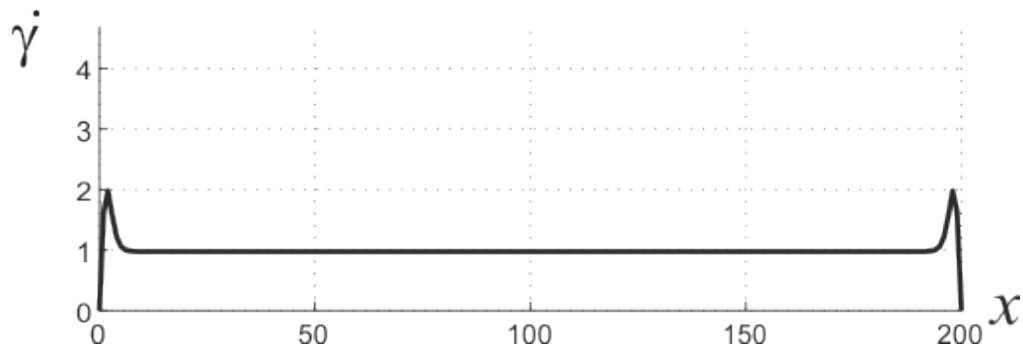
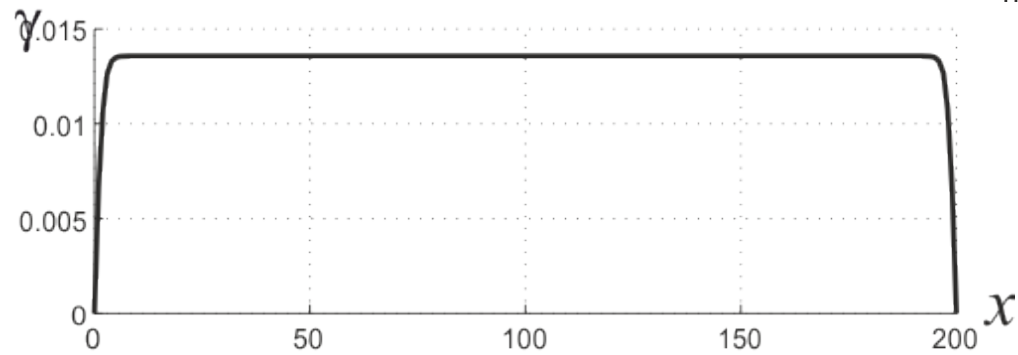
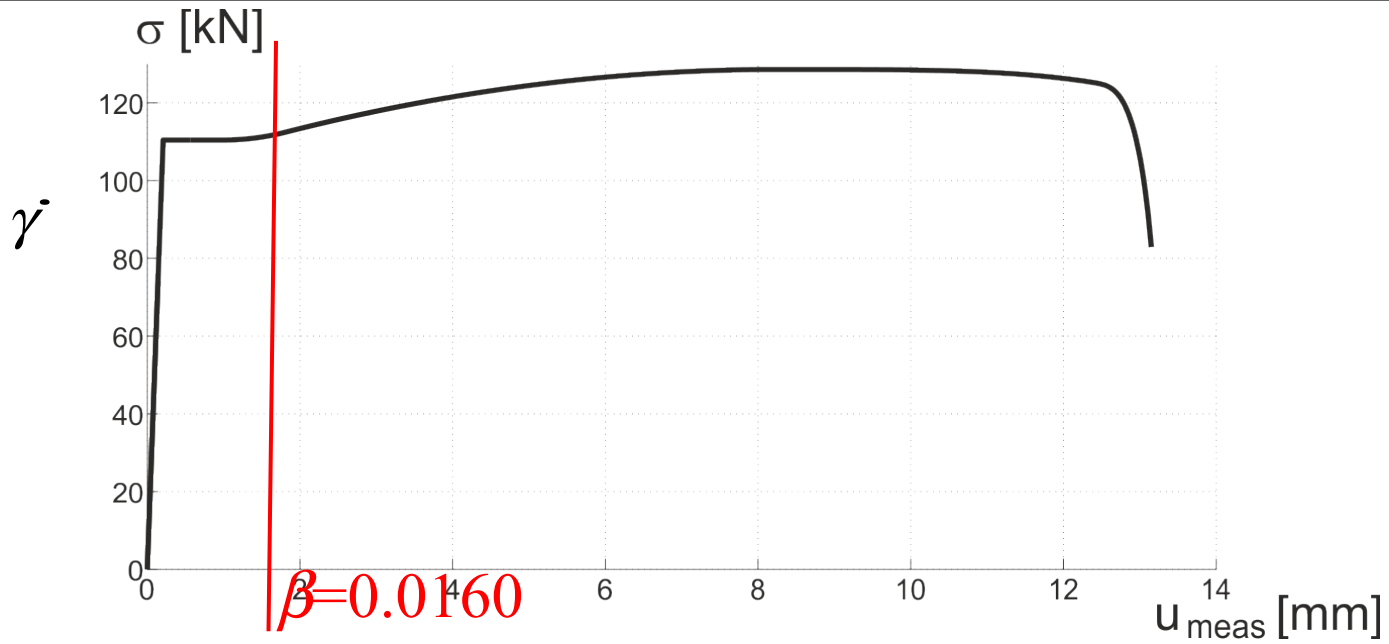




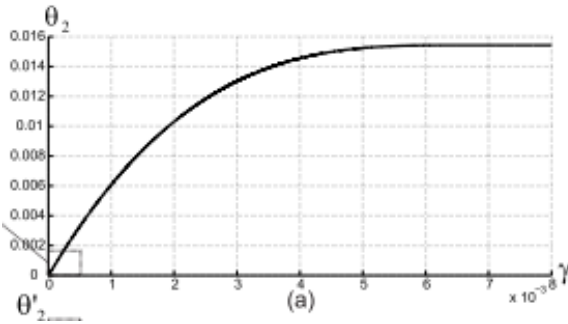
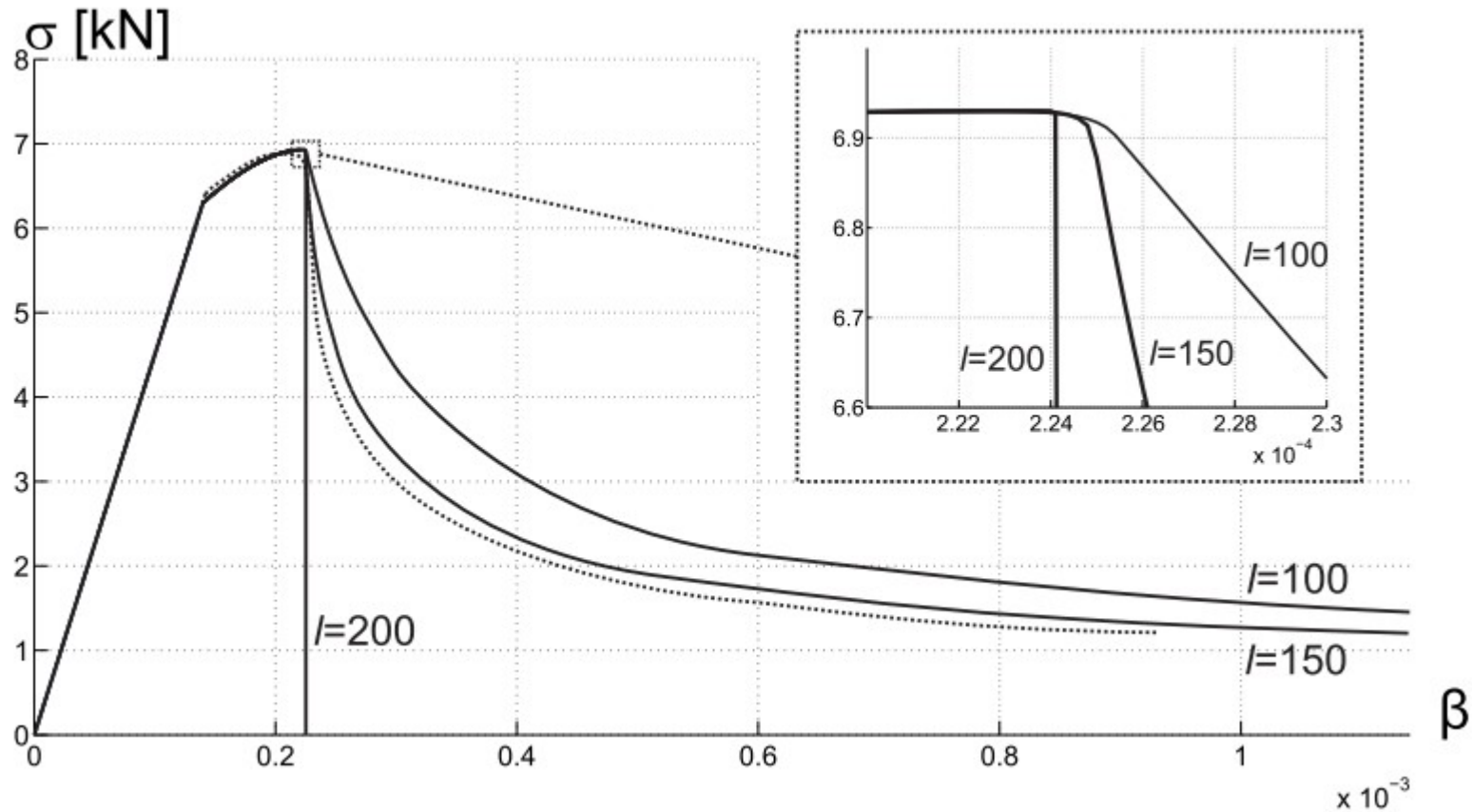






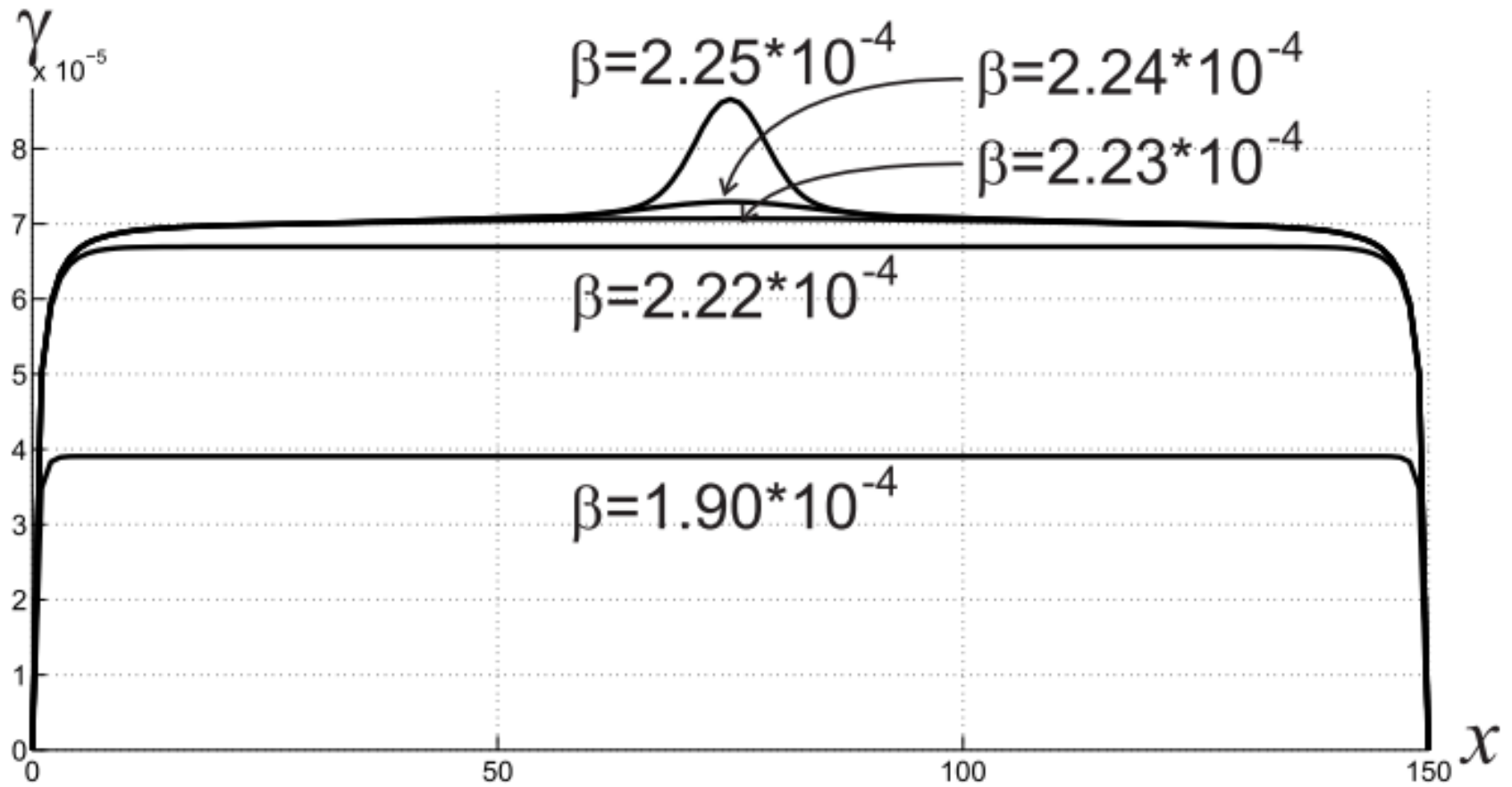


response curve of a concrete specimen

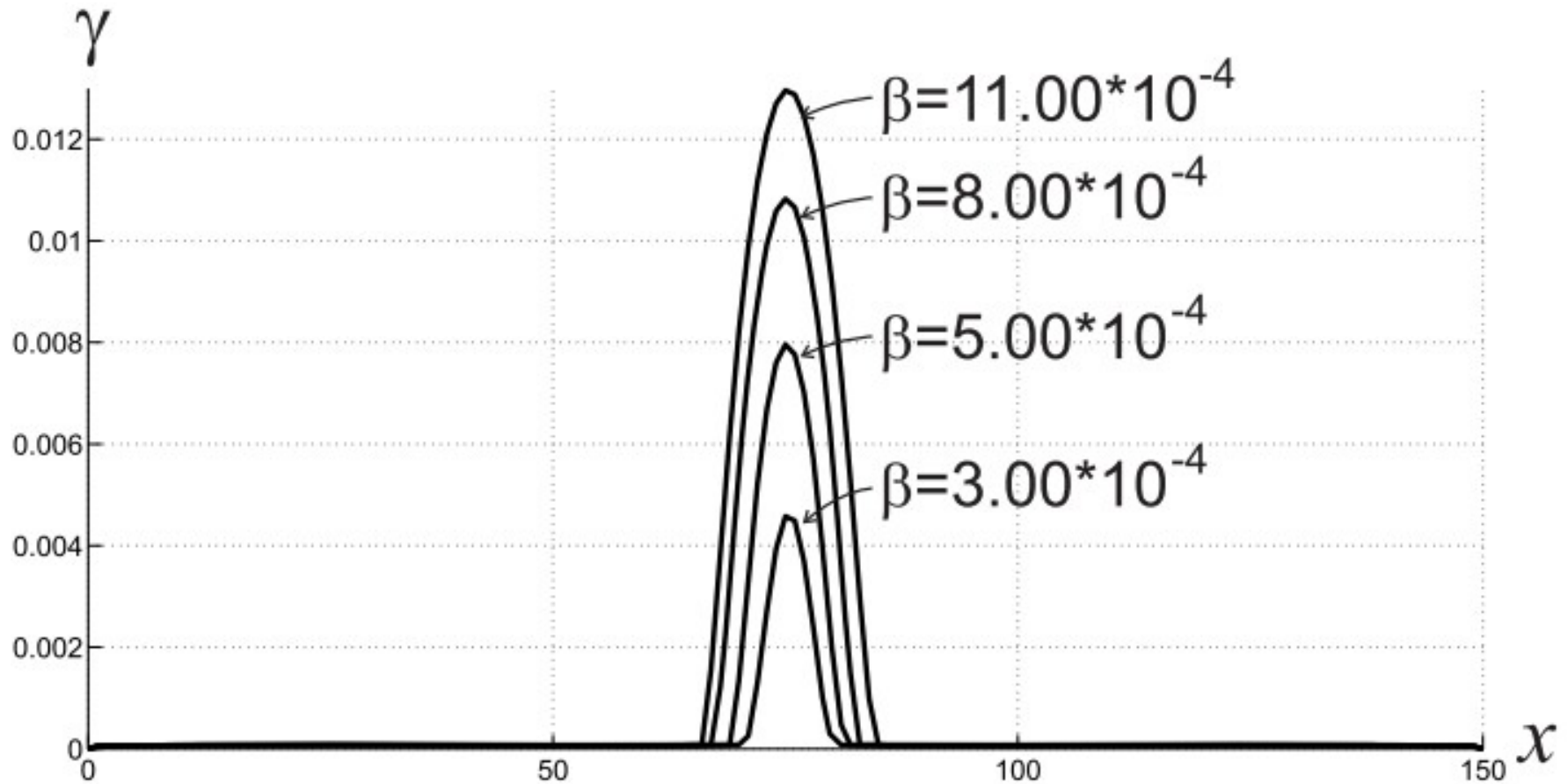


convex-concave cohesive energy
4 material constants

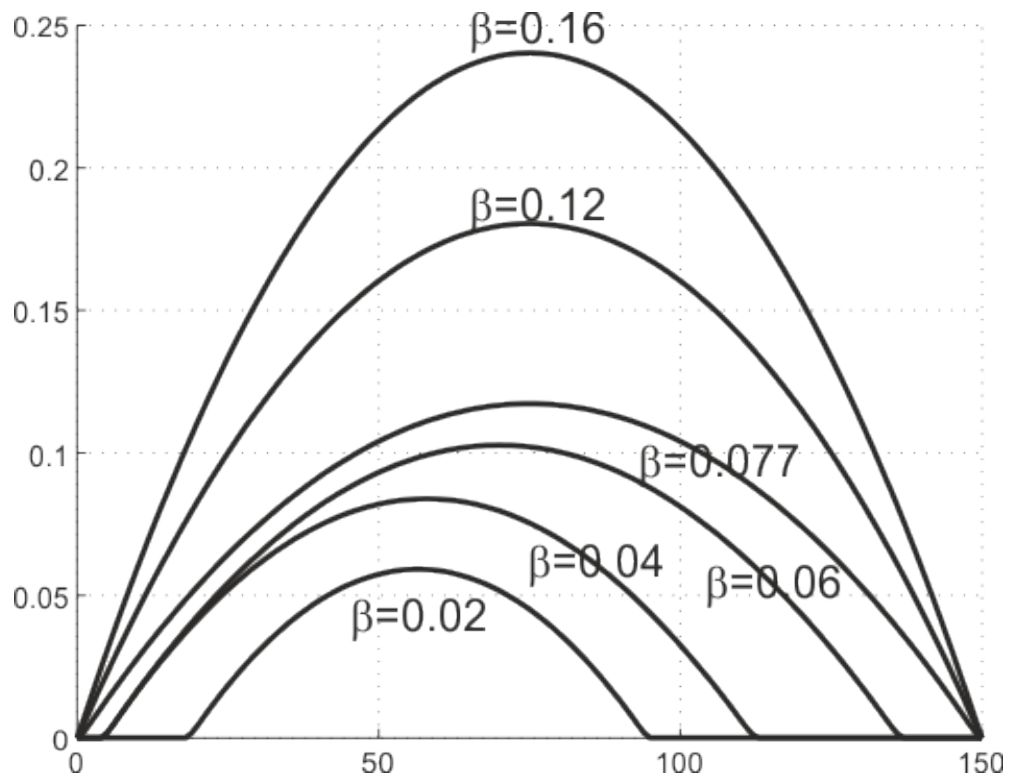
progressive localization ...

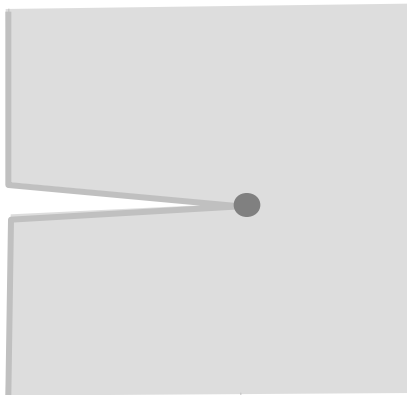


... followed by **diffusion**

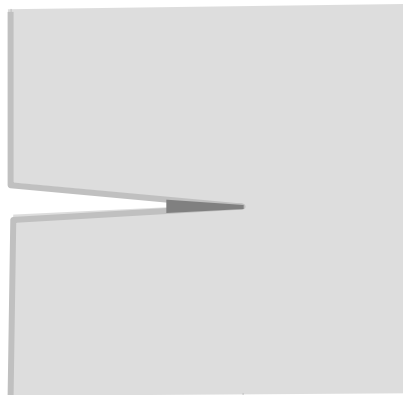


... over the whole bar

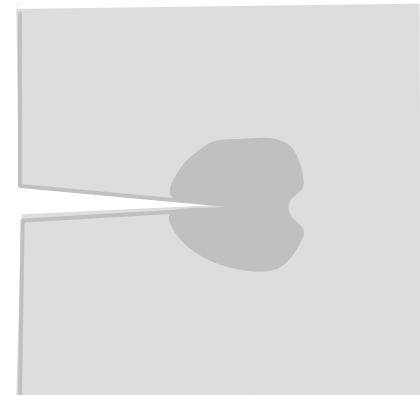




Griffith, 1920
brittle

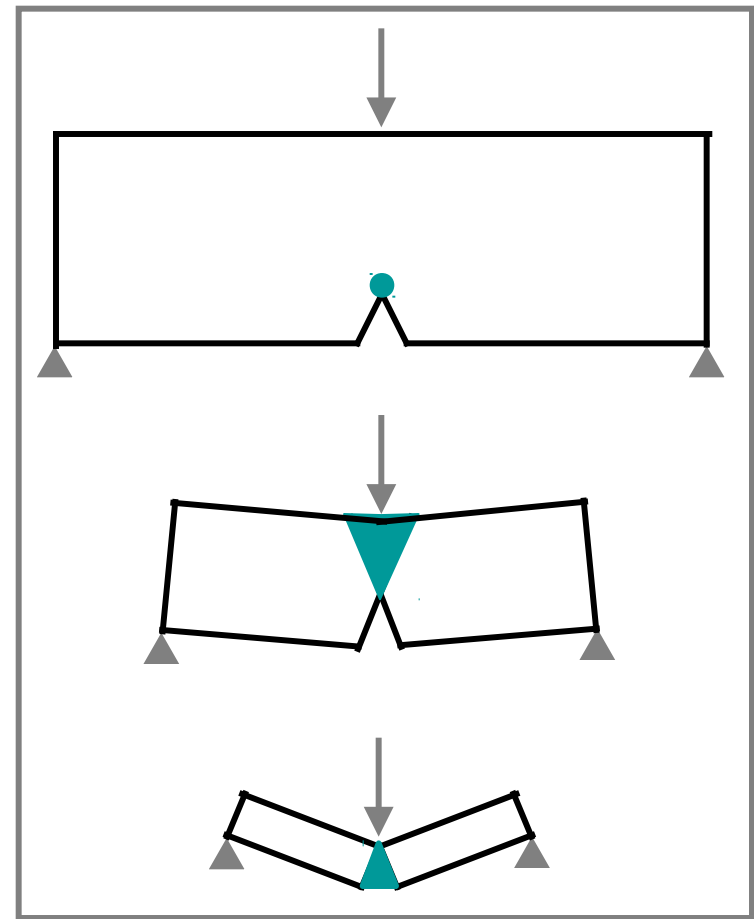
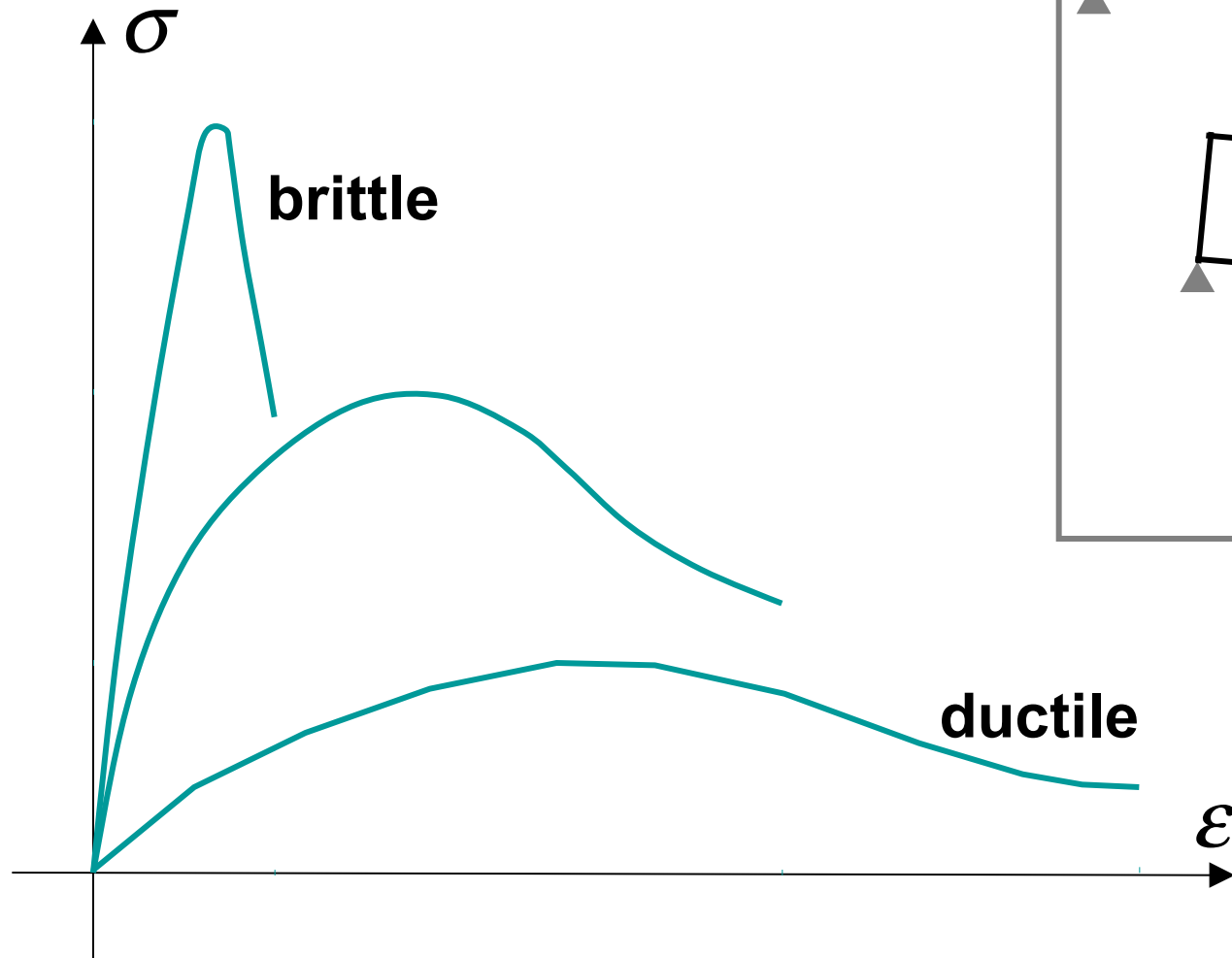


Barenblatt, 1960
cohesive



Irwin, 1955
ductile

the size effect





Il Duomo di Siena, 1229-1382

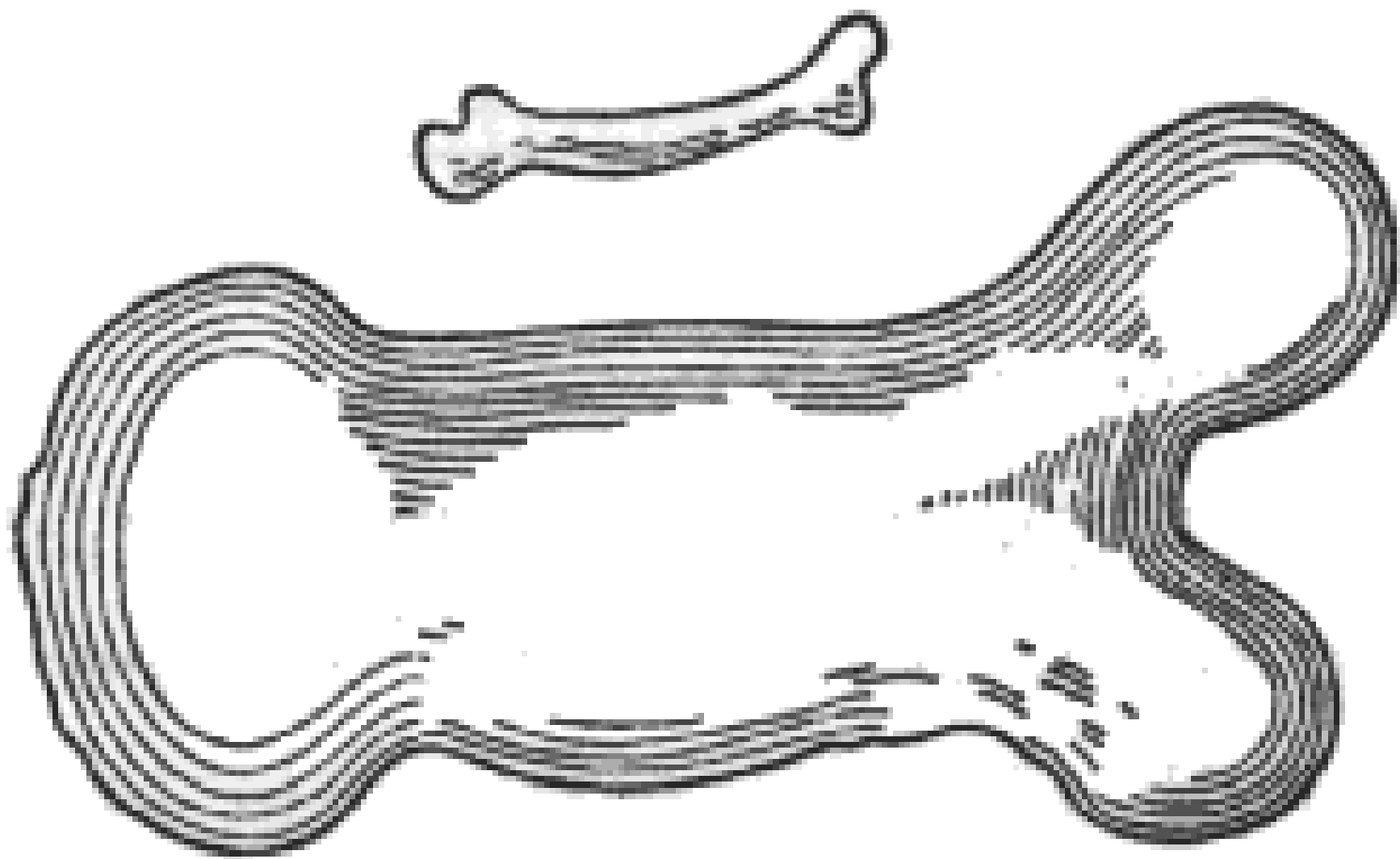
<http://brunelleschi.imss.fi.it/ist/luogo/duomosiena.html>



Esterno del Duomo di Siena



L'ampliamento, mai completato, del Duomo di Siena, 1340-1350



Galileo, Discorsi, 1638



Lepanto 1571



THE "GREAT EASTERN" STEAMSHIP COMING UP THE NARROWS INTO THE HARBOR OFF NEW YORK, JUNE 28, 1860.—[DRAWN FROM THE TELEGRAPH STATION ON STATEN ISLAND.]