UF Center for Infrastructure Protection and Physical Security (CIPPS)
UNIVERSITY of FLORIDA

Concrete Behavior under Impact

Size Effect

Concrete Strength reduces with increase in specimen size . Mainly caused by change in failure mode from plasticity to fracture.

$$\sigma_{Nc} = \frac{Bf_t}{\sqrt{1+\frac{D}{D_0}}}$$

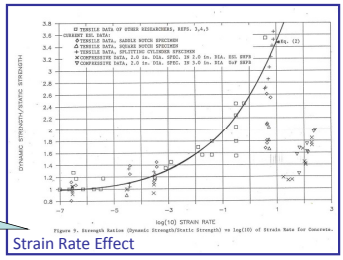
B, D_0, L_1, L_2 = constants

D/D_0 = relative structural size ratio. f_t = tensile strength

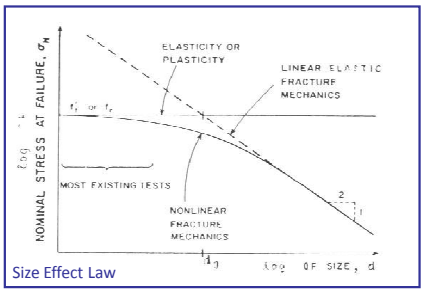
How do they interact?

Loading Rate Effect

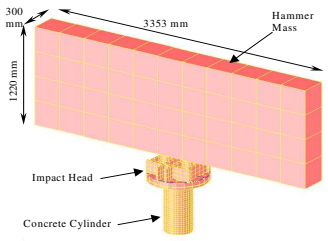
Concrete strength increases with higher strain rates. Caused by inertial effects.



Strain Rate Effect

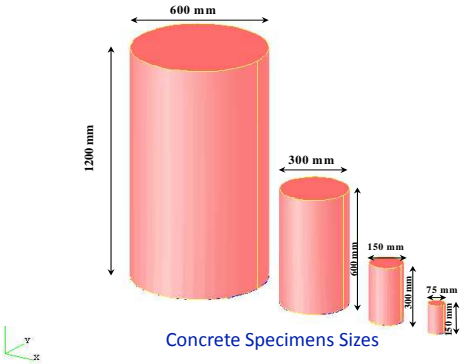


Size Effect Law

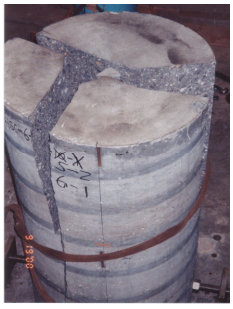


Simulated Test with PSU Drop Hammer

Present Study: Combined Testing and Simulations

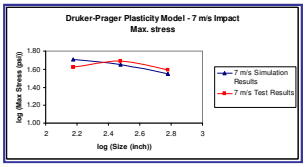


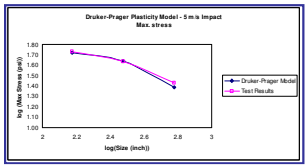
Concrete Specimens Sizes

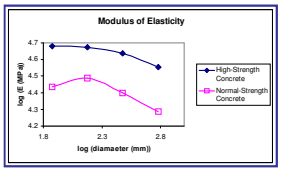


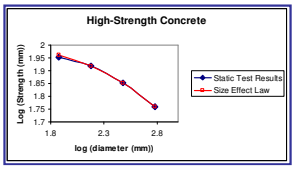
One Mode of Failure Observed in Tests

Sample Results









Key Conclusions

- A dynamic Size Effect that differs from the static Size Effect was observed.
- The existence of Size Effect was verified in parameters other than strength (e.g., modulus of elasticity and strain at maximum stress).
- The Size Effect Law predicted, almost exactly, the static strength values for both the high-strength and the normal-strength concrete cylinders.
- A variation of concrete strength with the variation of loading rate was observed.
- Two finite element models were developed using ABAQUS EXPLICIT. A Druker-Prager Cap Plasticity model and a Brittle Fracture model.