FRACTURAL MECHANICS OF CEMENT PASTE

Notched Three Point Flexural Test

- The three point bending flexural test provides values for

a. The modulus of elasticity in bending E

b. Flexural stress

c. Flexural strain and

d. The flexural stress-strain response of the material.

- The sample is placed on two supporting pins a set distance apart and a third loading pin is lowered from above at a constant rate until sample failure.

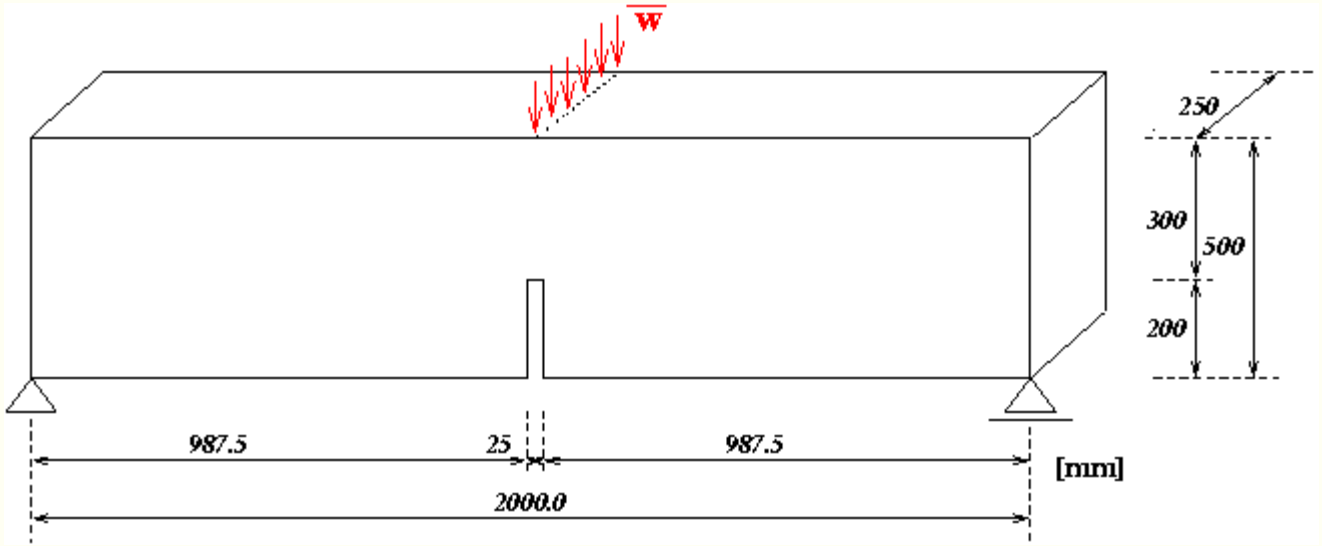
Notched Three Point Flexural Test

- The fracture toughness of a specimen can also be determined using a three-point flexural test. The stress intensity factor at the crack tip of a **single edge notch bending specimen** is

$$K_{\mathrm{I}} = \frac{4P}{B}\sqrt{\frac{\pi}{W}}\left[1.6\left(\frac{a}{W}\right)^{1/2} - 2.6\left(\frac{a}{W}\right)^{3/2} + 12.3\left(\frac{a}{W}\right)^{5/2} - 21.2\left(\frac{a}{W}\right)^{7/2} + 21.8\left(\frac{a}{W}\right)^{9/2}\right]$$

Design of Specimen and Experimental Setup.

- Figure diagram of a sample for illustration:



Design of Specimen and Experimental Setup.

- Dimension of specimens for Notched Three Point Bend test (in mm with tolerance of 5 mm):

Name	D	B	a	L	S
A1	30	40	15	200	180
A2	40	30	20	200	180
A3	20	45	10	300	270
A4	45	20	22.5	300	270

- Where D=depth of the beam, B=breath of the beam, a= depth of the notch, L=length of the beam, S=effective distance between supports.

HARDENED STATE CRACKING IN CEMENT PASTE

- **Drying Shrinkage Cracking** is commonly associated with the loss of moisture from the cement paste constituent producing a corresponding decrease in volume (shrinkage), coupled with restraints.
- **Thermal Stress Cracking** results when temperature variations due to weather exposure or (in more massive concrete structures) different rates of dissipation of the heat of hydration cause differential volume changes.
- The samples were taken out of the mold after 24hs and cured for three days.
- Hence, the absence of restraints, proper curing of porous paste and no thermal stress due to small size could be reasons for no observed cracking in cement paste specimens.

Casting of Cement Paste

- Cement to be used: OPC/PPC 53 grade.
- Water Cement Ratio : 0.3 and 0.4
- Curing Time: 21 Days
- Size of block to be cast: 15*15 cm.
- Specimen of dimensions A1 and A2, three of each kind were cast and cured for 21 days.
- A dummy sample of same dimension was cast to observe expected cracking in cement paste.
- No cracking was observed in the cube after 3 days of cracking.
- Further, cylinders of diameter 75cm were cut out of dummy sample cube to investigate internal cracking.

Experiment Setup

- The resources required for the experiment is available in Dept. of Mechanical Engineering.
- The setup is to be mount at the time of experimentation because it's components are already being used in other experiments.
- An image of the setup already used in an earlier experiment is displayed.

Relevant Standards

- ISO 12135: Metallic materials. Unified method for the determination of quasi-static fracture toughness
- ISO 12737: Metallic materials. Determination of plane-strain fracture toughness
- ASTM D790: Standard test methods for flexural properties of unreinforced and reinforced plastics and electrical insulating materials
- ISO 178: Plastics—Determination of flexural properties
- ASTM E1290: Standard Test Method for Crack-Tip Opening Displacement (CTOD) Fracture Toughness Measurement.