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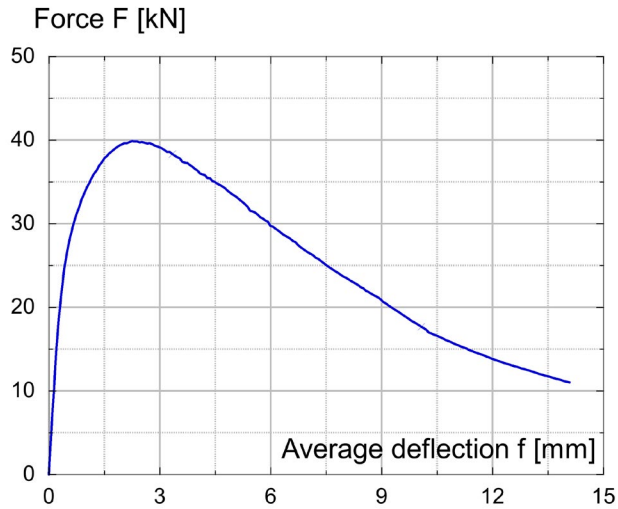
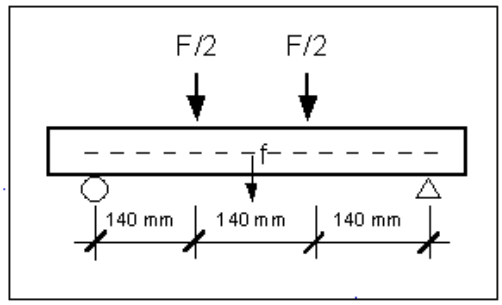
Exercise 8: Analysis of a bending test on UHPFRC plates, calculation of a structural element

The figure below shows the average curve obtained in a series of 4-point bending tests on 50 mm thick UHPFRC plates, with 10 mm long fibers. The plates are 200 mm wide, with a total length of 500 mm and a span of 420 mm between supports. The 2 points of application of loads are placed symmetrically at 140 mm of the supports.





Work to be carried out:

Using test results:

1. Determine the equivalent stress at peak force for the UHPFRC under test (the design force is assumed to be that at the peak).
2. Determine the effective tensile strength at peak force f_{Utu} .Assume that the neutral axis is at a distance from the tensioned underside of the plate equal to 80% of the height, and consider two contiguous rectangular stress blocks, for tension and compression.
3. Determine the force corresponding to the moment when the tensed lower fiber reaches the effective tensile strength f_{Ute} =11 MPa at mid-span (end of the linear elastic stage).
4. Assuming that the results of these tests can be transposed to a thicker structural element, what would be the load-bearing capacity of a simple beam made from the same UHPFRC, with a rectangular cross-section, 30 cm high and 20 cm wide, in 3-point bending, with a span of 5 meters? In this case, you can assume that the position of the neutral axis at the peak is approximately 80% of the total height, from the tensioned face, and that the effective tensile strength of the UHPFRC f_{Utu} is reached at the peak.
5. How much B500 steel reinforcement would be required in the tension zone of a reinforced concrete beam of the same geometry, with a 30 mm cover, to achieve the same load-bearing capacity?
6. Are these two variants equivalent in terms of ultimate-state behavior?
7. Discuss the results.

ED/ed - 09.2024