Response of High-strength Concrete to Dynamic Compressive Loading

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PII: S0734-743X(16)31083-1
DOI: 10.1016/j.ijimpeng.2017.04.015
Reference: IE 2903

To appear in: *International Journal of Impact Engineering*

Received date: 22 December 2016
Revised date: 18 April 2017
Accepted date: 18 April 2017

Please cite this article as: Y.B. Guo , G.F. Gao , L. Jing , V.P.W. Shim , Response of High-strength Concrete to Dynamic Compressive Loading, *International Journal of Impact Engineering* (2017), doi: 10.1016/j.ijimpeng.2017.04.015

Highlights

- Determination of rate-sensitivity of three high strength concretes (C60, C80, C110) with respective compressive strengths of ~60MPa, ~80MPa and ~110MPa.
- Enhancements to split Hopkinson pressure bar (SHPB) technique for testing high-strength concrete – e.g. elimination of gaps between specimen and the input/output bars by filling them with polyester adhesive to ensure good interfacial contact; use of two sequential pulse shapers to further enhance contact and achievement of a constant strain rate.
- Observation of significant rate sensitivity in high-strength concrete studied; quantification of rate-sensitivity via a Dynamic Increase Factor (DIF). Similar DIF values obtained for C60 and C80, but a much lower DIF for C110.
- CEB-FIP model (2010), usually employed to estimate rate dependence of normal strength concrete, found inadequate for estimating rate sensitivity in high strength concretes examined, especially C110.
- Finite element model for high-strength concrete established, based on mechanical properties derived from quasi-static compression tests, coupled with dynamic increase factors determined from dynamic tests. Simulation results for loading bar strain gauge signal histories in Hopkinson bar tests, correlate closely with experimental data, indicating that the rate dependence determined from dynamic tests represents actual material behaviour.
- Influence of radial inertia on compressive strength values obtained from dynamic SHPB tests examined via finite element simulation. Results show that for lower strain rates (~40s^{-1}), the effect of radial inertia is minimal; however, the influence of inertia increases with strain rate and cannot be neglected for higher strain rates (~100s^{-1} and beyond).