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Concrete — A Century of Innovation

ACI Sub-Committee 544-E

Mechanical Properties of FRCs

Agenda

Monday, October 16, 2017

5:00 PM – 6:30 PM

Disneyland Hotel
Anaheim, CA
Room: Explorer

1. Call to Order and Approval of the Agenda

2. Introductions

3. Status of the ongoing activities
   1) *Modeling of Mechanical Properties Under Blast and/or Impact Loading*
      – Status:
        a) *Ferrara has provided a draft on blast effects on FRC developed by di Prisco, Colombo and Martinelli, presenting blast effects on underground FRC structures conducted at the Politecnico di Milano.*
        b) *Vossoughi has provided a draft on the local impact behavior of FRC conducted at UC Berkeley*.
   2) *Creep of FRC*
      – Action: *Serna to report on the collected information on FRC creep activities.*
   3) *Stress – Crack Opening Behaviour of FRC*
      – Action: *Massicotte to report on the first Content draft.*

4. Future Topics and Documents

5. New Business

6. Adjourn

Modeling of Mechanical Properties Under Blast and/or Impact Loading Contribution from Vossoughi

Abstract

Different materials are used to reinforce structures against impact loading. In this section, a recent construction material, hybrid fiber reinforced concrete, is employed to resist impact loading. Different concrete based panels are subjected to impact by a steel projectile. The initial and residual velocities were measured experimentally and the energy absorbed by different panels with and without reinforcing fibers was calculated. It is observed that, including only 1% steel fibers can significantly reduce the visible damage comparing to control panels. The Hybrid panels were able to absorb high amount of energies without scabbing. The extent of damage, measured based on the volume of debris produced during the test, decreases for fiber reinforced concrete panels. Radial cracks followed by circumferential cracks are the starters for the back crater cone formation. Fibers can inhibit this process by bridging these cracks.

Keywords: Fiber; Hybrid Fiber Reinforced Concrete; Impact; Projectile; Penetration; Perforation; Energy; Damage.

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Terrorist attacks using explosives on underground structures such as tunnels and subway stations have intensified considerably in recent years (e.g. London – July 2005, Moscow – March 2010 and Brussels – March 2016). Explosions inside tunnels and subway stations could threat the lives of people inside it and may lead to the damage or failure of subway structures resulting in further loss of lives and socioeconomic losses. Explosions are, in several cases, the extreme consequence of fire accidents such as the detonation of a liquefied fuel. For their relevant infrastructural importance, the safety and security of underground structures are an actual and open issue.

The research carried out at Politecnico di Milano have investigated the case of tunnel made of Steel Fibre Reinforced Concrete (SFRC) and High Performance Fibre Reinforced Cementitious Composite (HPFRCC) in case of internal blast event. In particular, two main lines of research can be identified: (a) experimental campaigns carried out on FRC elements [3, 9] by means of a new shock tube facility conceived ad hoc for the study of soil-structure interaction [2, 6] and (b) the development of analytical and numerical procedures for the design of FRC tunnel lining in case of an internal blast occurs [1, 4, 5, 7, 8].

[1] Colombo, M., Martinelli, P., Di Prisco, M. Underground tunnels exposed to internal blast: Effect of the explosive source position (2016) Key Engineering Materials, 711, pp. 852-859.

[2] Colombo, M., Martinelli, P., di Prisco, M. On the blast resistance of high performance tunnel segments (2016) Materials and Structures/Materiaux et Constructions, 49 (1-2), pp. 117-131.

[3] Andreotti, R., Colombo, M., Guardone, A., Martinelli, P., Riganti, G., Di Prisco, M. Performance of a shock tube facility for impact response of structures (2015) International Journal of Non-Linear Mechanics, 72, pp. 53-66.

[4] Colombo, M., Martinelli, P., Di Prisco, M. A design approach for tunnels exposed to blast and fire (2015) Structural Concrete, 16 (2), pp. 262-272.

[5] Colombo, M., Martinelli, P., Huaping, R. Pressure-impulse diagrams for SFRC underground tunnels (2014) Computational Modelling of Concrete Structures - Proceedings of EURO-C 2014, 2, pp. 1023-1030.

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Modeling of Mechanical Properties Under Blast and/or Impact Loading Contribution from di Prisco, Colombo and Martinelli

Terrorist attacks using explosives on underground structures such as tunnels and subway stations have intensified considerably in recent years (e.g. London – July 2005, Moscow – March 2010 and Brussels – March 2016). Explosions inside tunnels and subway stations could threat the lives of people inside it and may lead to the damage or failure of subway structures resulting in further loss of lives and socioeconomic losses. Explosions are, in several cases, the extreme consequence of fire accidents such as the detonation of a liquefied fuel. For their relevant infrastructural importance, the safety and security of underground structures are an actual and open issue.

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