This is the published version:


Available from Deakin Research Online:

http://hdl.handle.net/10536/DRO/DU:30078488

Reproduced with the kind permission of the copyright owner.

Copyright : 2015, Thomas Telford (ICE Publishing)
Discussion: Effect of strain rate on splitting tensile strength of geopolymer concrete

Ke Nan Feng
Department of Civil Engineering, Monash University, Clayton, Victoria, Australia

Dong Ruan
Faculty of Engineering and Industrial Sciences, Swinburne University of Technology, Hawthorn, Victoria, Australia

Zhu Pan
Institute of Infrastructure Engineering, University of Western Sydney, Kingswood, NSW, Australia

Frank Collins
Department of Civil Engineering, Monash University, Clayton, Victoria, Australia

Yu Bai
Department of Civil Engineering, Monash University, Clayton, Victoria, Australia

Chien Ming Wang
Engineering Science Programme and Department of Civil and Environmental Engineering, National University of Singapore, Kent Ridge, Singapore

Wen Hui Duan
Department of Civil Engineering, Monash University, Clayton, Victoria, Australia

JR Marti-Vargas
Professor, IITECH, Institute of Concrete Science and Technology, Universitat Politècnica de València, Valencia, Spain

Contribution by Marti-Vargas
The discussed paper (Feng et al., 2014) presents test results on the effects of strain rate on the splitting tensile strength (f_t) of geopolymer concrete (GC) and geopolymer mortar (GM). Three GC mixes based on sodium (NaGC), potassium (KGC) and sodium/potassium (Na/KGC) and one sodium-based GM (NaGM) and one ordinary Portland cement (OPC) concrete mix were tested at strain rates of 10^-2 to 25/s. The dynamic increase factors of f_t (DIF_t) were measured and compared using the equations proposed by Malvar and Ross (1998), which were found to underestimate the DIF_t for GC. The authors should be complimented for producing this interesting paper, which provides new equations for GC. This is acknowledged by the discussers, who would like to offer some comments for the authors’ consideration and response.

Regarding the references cited in this paper, the discussers would like to point out that ACI 318-08 (ACI, 2008) and the CEB-FIP Model Code 1990 (CEB, 1993) are referenced by the authors, whereas there are later editions that were available prior to the paper submission date. In particular, equations for DIF_t according to Model Code 2010 (FIB, 2010) are not included, whereas the modified CEB recommendations (CEB, 1993) by Malvar and Ross (1998) are presented and used for comparison purposes. The equations in the aforementioned sources are similar in structure, but they differ in some parameters and in the threshold of strain rate considered, which is 30/s in Model Code 1990, 1/s in Malvar and Ross (1998) and 10/s in Model Code 2010.

The authors stated that, under a high strain rate loading (5–25/s), GC and OPC show similar values of DIF_t. However, Figure 6 shows DIF_t values of around 3 ± 0.5 for OPC, 2–5 for NaGC, around 5 ± 0.5 for KGC and 3–5 for Na/KGC. Therefore, it seems that there is a general trend for GC to reach greater DIF_t values, and even greater for GM (from 4 to 6). Also, in Figure 6, for all cases the predictions by Malvar and Ross (1998) were shown for comparison purposes. The discussers are confused about the apparent bilinear shape seen beyond a strain rate of 1/s, which it seems does not correspond to the power function according to the modified CEB recommendation based on Equation 2.

The typical failure modes of NaGC are shown in Figure 8, some of them for a strain rate loading of 25/s. However, the discussers notes that this strain rate does not appear in Figure 7(a). Perhaps the highly stressed volume (HSV) parameter (Marti-Vargas, 2014) could be used for complementary analyses.

Authors’ reply
The authors thank Professor Marti-Vargas for his comments on the discussed paper. The points mentioned in the discussion are important and worthy of clarification.

(1) In the discussed paper, the so-called modified CEB recommendations proposed by Malvar and Ross (1998) were adopted for comparison purposes. These modified CEB recommendations have been widely accepted and documented in the literature. In contrast, validations and applications of the Model Code 2010 FIB (2010) recommended by the discussers are still relatively limited. Therefore, the modified CEB recommendations were used in the discussed paper.

(2) The authors agree that there is a general trend to reach greater DIF_t values for GC, and even greater for GM, when compared with the modified CEB recommendations. However, the sample size of the geopolymer specimens tested was very limited, and further tests are expected to confirm this trend.

(3) As shown in Figure 6 in the discussed paper, beyond 1/s the continuous power function is discretised into two data points (strain rates 10 and 100/s) and connected with a linear function for simplicity. Figure 6(a) is reproduced as Figure 9 in this reply. The solid line is the power function according to
(5) An interesting comment raised by the discussers relates to the highly stressed volume (HSV) approach. One of the concerns about this approach is the definition of HSV, which appears to be strain-rate dependent, as shown in Figure 8 in the discussed paper. Further research is needed to examine the application of HSV over a wide range of strain rates.

REFERENCES
ACI (American Concrete Institute) (2008) ACI 318-08. Building code requirements for structural concrete and commentary. ACI, Farmington Hills, MI, USA.


