Tensile Behaviour of Polyurethane under Varying Strain Rates

H.M.C.C. Somarathna[1], S.N. Raman[2], K.H. Badri3, A.A. Mutalib[1]

[1]*Department of Civil and Structural Engineering, Universiti Kebangsaan Malaysia, 43600 UKM Bangi, Selangor, Malaysia.*

[2]*Department of Architecture, Universiti Kebangsaan Malaysia, 43600 UKM Bangi, Selangor, Malaysia.*

[3]*Polymer Research Centre (PORCE), Universiti Kebangsaan Malaysia, 43600 UKM Bangi, Selangor, Malaysia.*

Phone: +603 8911 8403; Email: hmccsomarathna@gmail.com, snraman@gmail.com

ABSTRACT

The elastomeric polymers are gaining the interest of structural and material engineers as a retrofitting material in numerous applications, such as to enhance the survivability of several types of structures under dynamic loadings, including blast, ballistic and impact. However, the behaviour of materials under these varying loading rates is yet to be investigated in detail. The primary hypothesis is that the behaviour of materials under dynamic loads can be explained by analysing the influence of varying strain rates, from static to high strain rates, on the characteristics of those materials. Therefore, when undertaking research on the behaviour of material under dynamic loadings, it is imperative to study the behaviour of materials at varying strain rate conditions. In the present study, the tensile stress-strain behaviour of a polyurethane (PU) sample was investigated through a series of uniaxial tensile test under a range strain rates (static to intermediate), from 0.001 s^{-1} to 0.1 s^{-1} . The findings of this study indicated that the mechanical characteristics of the polymers, such as the stress-strain behaviour, Young's modulus, failure stress, and failure strain were significantly influenced by the strain rates, and the PU material was found to be still exhibiting rubbery-like behaviour at enhanced strain rates. In addition, the findings of this study also provided good agreement with some recent studies discussing on the rate sensitivity of polymeric materials.

Keywords

Dynamic loadings; retrofitting; polyurethane; varying strain rates; tensile behaviour

1. INTRODUCTION

Elastomeric polymers, such as polyurethane (PU) and polyurea, are commonly used on numerous types of structural elements where these polymers provide extra capacity, and corrosion and abrasion resistance in severe environmental conditions. Applications include building structural elements (masonry, concrete, steel and composite elements), vehicles, underground structures (such as pipelines), marine constructions and etc (Chattopadhyay and Raju, 2007). More recently, PU has been of great interest among the structural and material engineers, and are also considered for the blast protection of several structural elements, due to its high toughness-to-density ratio under high strain rate conditions, and leads to enhance the dynamic performance and failure resistance under impulsive loads such as blast and ballistic (Davidson et al., 2004; Bahei-El-Din & Dvorak., 2007; Tekalur et al., 2008; Amini et al., 2010; Grujicic et al., 2012; Raman et al., 2012; Ackland et al., 2013). A simplistic technique to enhance the structural capacity and energy absorption capability of any structural