Ductility Design of High and Very High-Strength Reinforced Concrete Columns

Author : K.B. Kasun Shanaka
Email : kasunk@student.unimelb.edu.au
Supervisors : Prof. Priyan Mendis, Dr. Tuan Ngo
Department : Department of Infrastructure Engineering

THE UNIVERSITY OF MELBOURNE

Abstract: Design and construction of super-tall buildings has become a current trend in the Civil Engineering industry due to the land scarcity in the metropolitans caused by the rapid urbanizations. As well as, the regional competition to build iconic taller buildings in their capital cities has thriven the trend for the super-tall buildings. However, enormous loading conditions, such as gravity, wind and earthquake loads are associated with super tall buildings. Therefore, using the high strength and very high strength concrete (HSC and VHSC) columns, to sustain such extreme loading conditions, accepted to be a very economical option. However, due to the inherited brittleness and deficient guidelines for HSC and VHSC columns, particularly 80-150 MPa, HSC and VHSC are not being widely used in the industry. This research mainly focuses on improving the ductility using ligatures and developing guidelines for ductile design of HSC and VHSC up to 150 MPa.

Introduction

The ductility of structural members is an important parameter in structural engineering particularly to extreme loading conditions (such as earthquake loading) which structural members require to have large plastic deformation capabilities while sustaining its load carrying capacity. Thus, finding ductility demands in the structural analysis stage and providing required ductility are significant in the design of high rise buildings.

Even though, high strength concrete (50 - 100 MPa) and very high-strength concrete (100 - 150 MPa) can be commercially produced in-situ, the present codes only cover ductility design up to 80 MPa or restrict the use of HSC up to 80MPa for earthquake prone regions due to scarcity of knowledge on HSC and VHSC.

However, even the available provisions for ductility design are developed using equivalent static analysis methods though the super tall structures are required to be analysed using non-linear static and dynamic analysis. In addition, though the performance based design philosophies have been introduced, the ductility provisions for HSC have not integrated such philosophies.

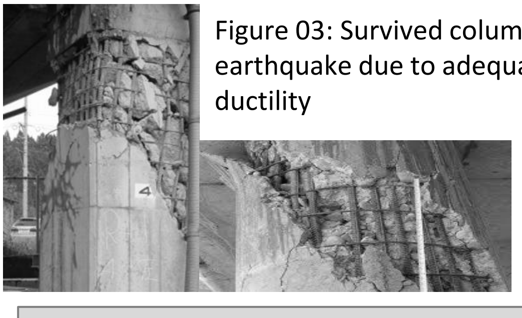

Figure 03: Survived columns after earthquake due to adequate ductility

Methodology

1. Develop more accurate techniques to predict moment-curvature relationship of HSC columns to evaluate ductility
2. Develop a stress-strain constitutive model for confined and unconfined concrete up to 150 MPa using experimental results
3. Eventually, develop theories for ductility design in order to extend the use of HSC and VHSC in columns up to 150 MPa.

Figure 01: Some proposed super tall buildings around the world

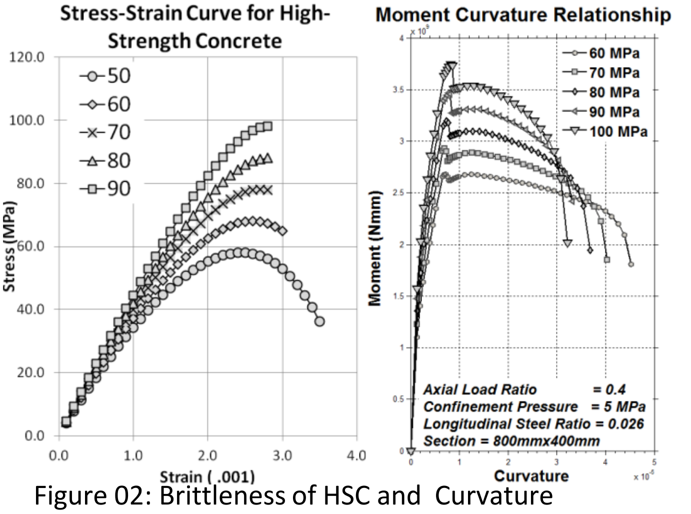

Figure 02: Brittleness of HSC and Curvature Ductility of HSC column

2013 Infrastructure Engineering Postgraduate Conference