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Energy Ductility of HSC Heavily Steel Reinforced Members under Bending

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Abstract

With the advent of advanced mineral and chemical admixtures, the strength level of concrete has been raised dramatically and high-strength concrete (HSC) is becoming more and more commonly used. However, HSC is generally more brittle than normal strength concrete. In the flexural design of reinforced concrete beams, apart from the provision of adequate strength, it is also necessary to provide a certain minimum level of ductility. In fact, it has been shown that the use of HSC, if not properly controlled, could significantly reduce the flexural ductility of reinforced concrete beams. A number of six heavily steel reinforced high strength concrete, HSC beams with different percentage of ρ and ρ′ were cast and incrementally loaded under bending. A test series with heavily reinforced concrete beams under four-point bending was performed to examine the ductility of structure. During the test, the strain on the concrete middle face and on the tension and compression bars and also the deflection at different points of the span length were measured up to failure. Based on the obtained results, the displacement and energy ductility of the HSC members are more deeply reviewed.

Keywords: Displacement and energy ductility, Plastic rotation, HSC.

1. INTRODUCTION

An advances in concrete technology recently, in many countries have now made practical use of concrete with strength up to 90 MPa. High Strength Concrete (HSC) provides a better solution for reduce sizes and weights of concrete structural members. The concretes with very high compressive strength can result in less ductile response of structural members. As a flexural element it is necessary for beam of high strength concrete to possess good ductility in seismic design and offer beforehand warning for structures by failing. In fact, it has been obvious for the researchers that the use of HSC, if not properly controlled, could significantly reduce the flexural ductility of reinforced concrete beams. Herein, it is proposed to compensate for the reduction in flexural ductility owing to the use of HSC by adding compression and confining reinforcements [1,2]. Although an apparent fragility of high-strength concrete when compared to normal strength concrete, the first tests on beams made by Ref. [3] in this area did not confirm this probable fragility

In this paper six rectangular HSC beams were cast to investigate the ductile behavior. In heavily steel reinforcement beams the displacement ductility for singly reinforcement is too close to the doubly reinforcement. Load-deflection curve was plotted. The displacement ductility factor μ_Δ was defined as Δ_u/Δ_y, where Δ_u is the displacement at which the compression concrete crushed, Δ_y is the displacement at which tension steel yields [4-6]. Based on the energy definition, the energy ductility μ_E, which is considered as ratio of total to elastic energy, was also calculated.

2. EXPERIMENTAL PROGRAM

Test Specimens: The program consisted of testing six heavily reinforced HSC beams tested in flexure. The details of test beams are presented in Table 1 and Figure. 1. Three beams were singly reinforced and the other three were doubly reinforced. Shear reinforcements were provided along the beam length except in the constant moment region. The variable was the compressive reinforcement ratio, ρ′. Table 1 presents the detailed testing program, where one or two letter followed by a number, such as BC6 or B6, designate the specimens. The letters BC indicated the beams having compression bars too. The numeral 6 to 8 indicates the variation on ρ and ρ′.