Rheological Properties, Segregation Resistance and Compressive Strength of Self-Consolidating Lightweight Concrete incorporating Natural Zeolite

Mahdi Mahdikhani[1], Seyyed Naser Amini[2], Hamid Bayat[3]

1- Assistant Professor, Civil Engineering Department, Faculty of Engineering, Imam Khomeini International University, Qazvin, Iran

2,3- Civil Engineering Department, Faculty of Engineering, Imam Khomeini International University, Qazvin, Iran

naser_ce89@yahoo.com

Abstract:

This paper presents the fresh and mechanical properties of Self-Consolidating Lightweight Concrete (SCLC) containing Natural Zeolite (NZ) assessed by means of slump flow, flow time, V-funnel, L-box, column segregation, compressive strength and cross-section image tests. The test results indicate that incorporation of NZ generally improves mechanical and rheological characteristics of the concrete mixtures. In the hardened state, by increasing NZ, the compressive strength was increased up to 14% and 25% at the age of 7-days and 28-days, respectively. In addition, the results show that NZ enhanced aggregate segregation of SCLC. In addition, the viscosity of SCLC increased when the percentage of NZ increased. As the results of column segregation and L-box tests show, segregation resistance ability was increased by higher proportion of NZ and finally segregation resistance and passing ability were increased at higher proportion of NZ and finally segregation was qualified in mixture with 12% NZ.

Keywords: Self-Consolidating Lightweight Concrete, Lightweight Aggregate, Compressive Strength, Segregation Resistance, Natural Zeolite.

1. INTRODUCTION

Self-compacting concrete (SCC) is a type of concrete which can be placed and compacted under its own weight with little or no vibration through confined spaces such as areas of congested reinforcement without segregation or bleeding. This kind of concrete, with the essential fresh concrete properties such as filling ability, passing ability and segregation resistance, introduces benefits in workability, that causes the elimination of the need for vibration, reductions of construction time, noise vibration and labor costs and higher strength properties compared to those of traditional concrete. [1-8]

Despite all advantages associated with the use of concrete in infrastructures, its high self- weight compared to other construction materials, almost make it inadequate because of increasing their risk due to earthquake acceleration [9]. In addition, the properties of light weight aggregate concrete (LWAC) include heat insulation, sound absorption, ease of use and reducing the areas of sectional members as well as making the construction convenient [10-16]. Thus, the construction cost can be saved when applied to structures such as long span bridge and high rise buildings [17]. It has been successfully used in buildings where soil conditions are poor, to highly specialized structures such as floating structures and offshore platforms [18].

Vibration of lightweight concrete tends to be less efficient because the lightweight coarse aggregates move the upward and form a weak layer [19-23]. Thus, Noticeable handicap of LWAC is segregation of lightweight coarse aggregates during the transporting and placing the fresh concrete [24]. This weakness of LWAC can be compensated by incorporating lightweight aggregate in self-consolidating concrete [25-28]. Some laboratory research has been conducted to study the use of lightweight aggregate (LWA) in the production of SCC [29, 30]. In addition, Sugiyama [31] and Domone [32] have reported the SCLC application in bridge decks, repair work and the strengthening of structural panels in japan. The presence of mineral additions (MAs) in cement-based materials has grown in recent years because it thus affords many advantages including the following: (i) the reduction of environmental issues; (ii) affects the workability in the fresh state of concretes specially in SCC; (iii) the enhancement of concrete strength and sustainability [33-37]. Siddique [38] found that the pozzolanic and filler effect of silica as cement replacement increase the strength. Despite the pozzolanic activity of natural zeolite (NZ) is lower than silica fume, undesirable