Periodicals of Engineering and Natural Sciences ISSN 2303-4521
Vol. 9, No. 2, June 2021, pp.1124-1140

Flexural behavior of two-layer beams made with normal and lightweight concrete layers

Hayder Kadhem Adai AL-Farttoosi[1], Haleem K. Hussain[2], Oday A. Abdulrazzaq[3]
[1] Civil Engineering, University of Basrah
[2] Civil Engineering, University of Basrah
[3] Civil Engineering, University of Basrah

ABSTRACT

In this paper, twelve concrete beams with two different layers of concrete were evaluated as a simply supported beam under four-points loading. The beams assembled of two different types of concrete layers, one of which was normal-weight concrete (NWC) and the other was lightweight aggregate concrete (LWAC). The investigated parameters were the thickness of the lightweight concrete to the overall depth of beams (hLW/h), and the compressive strength of normal and lightweight concrete. Due to the weak lightweight aggregates used, lightweight aggregate concrete exhibits more brittleness and lower stiffness. Therefore, the viability of compensating for this degradation and providing a layer of normal concrete seems to be very interesting in such beams. The behavior of beams was evaluated based on cracking, failure mode, flexural strength, maximum deflection, stiffness, and toughness. The results showed slight variations on the majority of the above-mentioned performance aspects of two-layer beams compared to fully normal concrete beams. While there were great enhancements compared to fully LWAC beams. The variants were mainly attributable to the efficacy of using LWAC in providing lower stiffness and lower tensile strength. The experimental results have been compared to predicted values using the ACI 318-19, with some modifications for the equations to be matched with two-layer beams, the comparison was in terms of the deflection due to service load, moment capacity, and cracking moment.

Keywords: Layered beams, two-layer RC beams, LWAC beams, NWC beams.

Corresponding Author:

Hayder Kadhem Adai AL-Farttoosi,
Civil Engineering,
University of Basrah,
Iraq/ Basra.
E-mail: Hayder.k.alfarttoosi@gmail.com

1. Introduction

The rapid development of high-rise buildings, larger sizes and longer spans concrete structures necessitated the use of concrete that performed well in terms of strength, toughness, and light weight, the latter being related to the density of concrete. A lower density leads to a reduction in dead loads in structural design and foundations, which allows for a decrease with in horizontal inertia actions on buildings in earthquake regions. In comparison to normal weight concrete (NWC), lightweight concrete (LWC) shows more brittleness and lower stiffness[1], [2].

These variance in mechanical properties of NWC and LWC reveals an idea to combined both concretes in structural composite elements [3], [4]. The structural composite elements are typically made up of two materials: one carries the majority of the flexural loads, and the other is a thick, while the low-weight core increases shear ability and the section's moment of inertia. Such types of composite system are becoming more commonly adopted in the peculiarly industry of conservative infrastructure construction, due to their cost-effectiveness, high strength to weight ratio, excellent durability, good impact resistance, excellent fatigue and corrosion resistance, and design flexibility. Such composite systems are mainly used for structural roofs, walls, floors, and bridge decks. [5].