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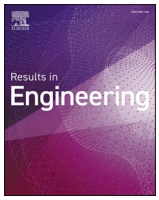

Research paper

Shear strength and behavior of eco-friendly RC corbels

Kadhim Z. Naser *, Abdulamir Atalla Almayah, Abdulnasser M. Abbas

Department of Civil Engineering, College of Engineering, University of Basrah, Basrah 61004, Iraq

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ABSTRACT

The use of efficient and environmentally friendly materials is a priority in the construction industry. In this study, the behavior of reinforced concrete corbels made of recycled concrete aggregate (RCA) was investigated. Twenty models were created and categorized into five Groups to examine various factors influencing the characteristics of the corbels. These factors included the replacement ratio of natural coarse aggregate with varying proportions of RCA, with a replacement ratio of 0 % designed for the reference mixture; the other mixtures had replacement ratios of 20 %,40 %, and 60 %. Additionally, the study assesses the amount of main and secondary reinforcement, the shear span-effective depth ratio (a/d), and compressive strength. The influence of these variables on ultimate load capacity, load-deflection curves, crack pattern, initial stiffness, and energy dissipation was investigated. The results indicated that the use of recycled concrete aggregate did not significantly affect the pattern of cracks, type of failure, and energy dissipation capabilities. At the same time, it had a modest impact on the ultimate load capacity, with a decrease of 4.4 %, 8.6 %, and 16 % at a replacement ratio of 20 %,40 %, and 60 %, respectively. Correspondingly, deflection increased from 3.63 mm to 4.27, 4.92, and 5.61 mm at the same replacement ratio. Furthermore, it was also noted that increasing replacement ratios resulted in a slight decrease in initial stiffness. The ultimate load capacity of the corbels was predicted using the theoretical equations proposed by the provisions of the ACI 318 code and the equations proposed by previous literature. The results indicated that using the equations proposed by Hwang et al. and Chetchotisak et al. provided more accurate estimates compared to the other models, yielding a coefficient of variations (COVs) of 4.8 and 5.1 %, respectively. In contrast, the values derived from the code equations were significantly more conservative.

1. Introduction

The use of recycled aggregate in the production of concrete structures is attaining high research attention in the present time since it contributes in maintaining natural resources on one hand, and reduces the environmental attack of the process of demolishing structures on the other hand. The dark side of the issue is that the use of recycled aggregate often results in concrete of lower strength and elastic properties than concrete using aggregate from natural sources. This is why many research efforts were spent to evaluate the strength and behavior of structural components made of concrete incorporating recycled aggregate [1–4]. In the present work, the use of recycled aggregate as a partial replacement of the natural aggregate in reinforced concrete corbels subjected to vertical load is examined concerning their deflection and crack and failure loads. The utilization of recycled aggregates, encompassing both coarse and fine aggregate types, has been the subject of significant research in recent years. Investigation into these materials has been conducted across various domains within structural engineering [5–15].

Corbels can be thought of as short cantilevers projected from columns or walls and subjected to vertical and horizontal forces from beams resting on them [16]. They are commonly used in workshops with crane girders and other pre-cast reinforced concrete buildings. These elements generally have shear span-depth ratios of less than unity [17]; thus, the classical flexural theory cannot be used to determine their strength. This is because the three-dimensional state of stress in the region between the applied load and the reaction at the support, which makes the assumption of plane section before bending remains plane after bending is no longer valid. So many attempts were made to predict the shear strength of the reinforced concrete corbels by using experimental and analytical studies [18–25]. Among those studies, Campione (2009) [26] studied the flexural behavior of ordinary and fiber-reinforced concrete corbels under vertical and horizontal loads, proposing a strut-and- tie-based analytical model. Key parameters

* Corresponding author.
E-mail address: kadhim.Naser@uobasrah.edu.iq (K.Z. Naser).

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