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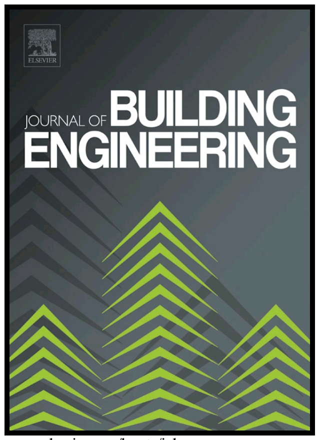

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Ammar N. Hanoon, M.S. Jaafar, Salah R. Al Zaidee, Farzad Hejazi, F.N.A. Abd Aziz

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Ammar N. Hanoon[1,2,a], M. S. Jaafar[1,b], Salah R. Al Zaidee[3,c],Farzad Hejazi[1,d], and F. N. A. Abd Aziz[1,e]

[1]*Department of Civil Engineering, Universiti Putra Malaysia, Malaysia.*

[2] *The engineering affairs department, Baghdad University, Iraq.*

[3] *Department of Civil Engineering, Baghdad University, Iraq.*

[a]*civileng.ammar@gmail.com (corresponding author),* [b]*msj@upm.my,* [c]*salahalzaidee2004@gmail.com,*

[d]*farzad@fhejazi.com,* [e]*farah@upm.edu.my.*

ABSTRACT: In the current study, a new strut effectiveness factor based on Strut-and-Tie Model (STM) was proposed to assess the ultimate shear strength of carbon fiber reinforced polymer (CFRP) strengthened concrete deep beam. Derivation of new effectiveness factor of concrete struts is based on the failure principles of Mohr–Coulomb. Two types of concrete failure mode, namely diagonal splitting and concrete crushing are proposed and investigated. Experimental results obtained from the literature results were evaluated using the proposed effectiveness factor and compared with other existing models. The proposed effectiveness factor is validated by utilizing the experimental results which shows good accuracy for predicting the shear strength of CFRP-strengthened concrete deep beams.

KEYWORDS: Deep beam; Strut effective strength; CFRP; Shear strength; Strut-and-tie model.

1. INTRODUCTION

Given the ability of reinforced concrete (RC) deep beams to sustain heavy loads, most infrastructures, such as bridges and buildings, use these beams as main structural components. The behavior of such structural components is described by the nonlinearity of strain-stress distribution that occurs because of its relatively low shear span-to-depth ratio (a/d). Hence, its behavior varies from the conventional beam, and the assumptions of beam theory cannot be held. Moreover, with a normal flexural steel reinforcement ratio, the shear failure is controlled. As a result, the necessity to modify methods used for assessing the ultimate shear strength of deep beams has become more significant in recent literature topics.

The strut-and-tie model (STM) has gained rapid acceptance in its design and analysis of RC deep beams [1-6] and for the recommendation of numerous codes, such as in [7-12]. In this model, compressive and tensile forces can be carried by concrete struts and ties, respectively. A reduction in concrete strength can be counted by a concrete strength efficiency factor that occurs because of transverse stress and cracks, a reduction that is generally applied to the strut [6, 13, 14].

Many studies have been carried out to evaluate the shear behavior of slender beams strengthened with carbon fiber reinforced polymer (CFRP) sheets, and several design formulas have been proposed to estimate the shear strengths of such beams. By contrast, relatively few studies have been conducted related to the evaluation of the ultimate shear capacity of CFRP-strengthened RC deep beams, and its design criteria are still under development. Based on the current design codes, such as the ACI building code [8], an RC deep beam should be analyzed utilizing the STM, which considers the complex stress flow in D-regions. To use this model to the design of CFRP-strengthened RC deep beams, several modifications of design factors are required. Therefore, this study aims theoretically to examine the ultimate shear capacity of CFRP-strengthened deep beams and suggests a new strut effectiveness factor (*v)* that is utilized in the STM for the design of CFRP-strengthened deep beams. This factor plays a significant role in the STM design of RC deep beams and shear capacity prediction.

Various variables, such as material properties, beam size, steel reinforcement, and structure loading, affect the value of the effectiveness factor [15, 16]. According to MacGregor et al., 1997 [17], the effectiveness factor varies from 0.25 to 0.85 based on the concrete strut in the plastic truss model utilized to estimate the deep beam capacity.

To the best knowledge of the author, scant studies have been conducted to improve the STM to design and analyze CFRP-strengthened RC deep beams theoretically. Thus, the main objective of