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Review on Design and Analysis of RCC structures

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Abstract: The reinforced concrete structures are used in various high rise and commercial buildings. The current research is intended to review the existing studies on RCC beam using experimental and numerical method. The numerical analysis is conducted using different types of FEA tools like ANSYS. The effect of various design and material type on flexural strength and stiffness of beam presented by various researches.

Key Words: *RCC, flexural strength, composite beam*

1. INTRODUCTION:

The reinforced concrete structures were designed to take the static loads. But in nature, floors subjected to crowd, vehicle vibration in road pavements, traffic load in bridges, wind and wave action in marine structures gives cyclic or fatigue load to the structure. Fatigue is generally effect of degradation, which reduces the structural service life. The service life of reinforced concrete structure directly depends on the stress level, stress range and number of the loading cycles during the cyclic loading. The reinforced concrete structures were designed for the load bearing capacity. Due to the fatigue loading, the repeated application of stresses causes the structure fail to before reaching the ultimate load carrying capacity under static loading. High-cycle fatigue fracture of the main steel reinforcement in structures subjected to cyclic loads fails in the positive moment region.

2. LITERATURE REVIEW

Saksena and Patel et. al. [1] The effect of small circular opening on the shear and flexural and ultimate strength of beams. was studied. The changes of diameter and openings positions are the main factors of their study. The results showed that the presence of diagonal reinforcement and stirrups in top and bottom of opening is more significant.

Vengatachalapathy and Ilangovan et. al. [2] studied experimentally the behavior and ultimate strength of steel fiber reinforced concrete (SFRC) deep beams with and without web openings subjected to two-point loading.

Amin et al. (2013) [3] Nine reinforced concrete deep beams with dimensions of 750 mm 9 350 mm 9 75 mm were tested to destruction by applying gradually increased load. The theoretical formula obtained by Kong and Sharp's was modified to calculate the ultimate load which compared by experimental results. The results gives clear indicator that the behaviour and strength of deep beam affected by the location of openings and the amount of web reinforcement, either in the form of discrete fibers or as continuous reinforcement. The effects of opening sizes and locations on the shear strength behaviour of reinforced concrete deep beams without web reinforcement were studied.

El Maaddawy and Sherif et. al. [4] investigated thirteen deep beams with openings under four-point bending to examine the potential use of externally bonded CFRP composite sheets as a strengthening solution to upgrade this kind of beams. All beams has same rectangular section of 80 - 500 mm and 1200 mm length, Test parameters included the opening size, location, and the presence of the CFRP sheets.

Diggikar et al. [5] Externally bonded CFRP shear strengthening around the openings was found very effective in upgrading the shear strength of RC deep beams. The strength gain caused by the CFRP sheets was in the range of 35–73 %. Results predicted from theoretical methods compared with experimental results were within a 15 % error band and varied between 0.92 and 1.34 for un-strengthened and strengthened specimens, respectively. The behaviour of RCC beam with rectangular opening strengthened by CFRP and GFRP sheets were studied.

Ali et al. [6] investigated the effect of the shape and dimensions of opening on the behaviour of RC beams and

they was examined the effectiveness of CFRP reinforcement in enhancing the flexural capacity of RC beams with opening at the flexural region. Results obtained from the study show that the L h ratio and FRP sheets has great effect to increase the stiffness and capacity of all beams.

Chin et al. [7] Strengthening RC beams with large circular and square opening located at flexure zone by CFRP laminates was studied.

Vuggumudi et. al. [8] They were explained clearly from the test results that large opening at flexure reduces the beam capacity and stiffness; and increases cracking and deflection. Test results showed that large opening at flexure reduces the beam capacity and stiffness; and increases cracking and deflection. An extensive experimental program consisting of testing 11 full scale RC beams were carried out.

Mahmoud et. al. [9] A finite element FEM reinforced concrete model by using ANSYS 9 finite element program for both un-strengthened and CFRP-strengthened beams with concrete element model 25 9 25 9 25 mm and discrete and smeared steel elements models was analysed.

Al-Shaarbaf et al. [10] developed a three-dimensional nonlinear finite element model suitable for the analysis of reinforced concrete beams with large openings under flexure. Numerical studies including some material parameters such as concrete compressive strength, amount of longitudinal tensile reinforcement and opening size on the load–deflection response were conducted. The finite element results showed that the extent of the bottom steel reinforcement decreased with an increase in the length or depth of the opening and the ultimate load and post-cracking stiffness increased with an increase in the concrete compressive strength.

Hawileh et al. [11] developed 3D nonlinear finite element (FE) models for twelve reinforced concrete deep beams containing web openings and strengthened in shear with CFRP composite sheets. They used the FE models, solid elements for concrete, multi-layer shell elements for CFRP and link elements for steel reinforcement to simulate the physical models. The developed FE models can serve as a numerical platform for performance prediction of RC deep beams with openings strengthened in shear with CFRP composites.

Amiri and Masoudnia et. al. [12] Two cases of simply supported reinforced concrete rectangular section beams with circular and square opening were investigated numerically. The results obtained from finite element analysis software (ANSYS 10) showed that the performance of the beams with circular openings with diameter less than 0.48 of the beam depth has no effect on the ultimate load capacity of the RC rectangular section beams. The ultimate shear capacity of the beams reduced by 26 % when the opening exceeding 0.48D

Fahmy and Hassanein et. al. [13] used finite difference method and developed analytical model to investigate the behaviour of composite beams with web openings. Variation of the shear force along the opening length is considered, the results conducted by analytical model were compared with some available experimental results and showed good agreement.

Mofidi et al. et. al. [14] An analytical study on reinforced concrete T-beams strengthened in shear with L-shaped FRP plates was presented to develop design equations for RC beams retrofitted in shear using L-shaped FRP plates

Mohamed et al. [15] used finite element method to predict the behaviour of reinforced concrete deep beams with web openings. The effect of the reinforcement distribution on the beam overall capacity was studied and results compared to the Egyptian code guidelines and shown good agreement. They concluded that the reduction in beam's capacity ranged from 6 to 8 % depending on the opening dimensions, the depth of the opening should not exceed 20 % of the beam overall depth (0.2d) and the reinforcement distribution should be in the range of 0.1–0.2H for simply supported deep beams. Osman et al. [16] State of the art work on the behavior, analysis and design of RC beams with transverse web openings presented to discuss the structural behaviour, classification of openings and guidelines for opening location of RC beams with web openings by various design approaches such as the American Concrete Institute (ACI) approaches, the Architectural Institute of Japan (AIJ) approach and the strut and tie method

Chin et al. [17] presented two dimensional nonlinear finite element analyses of RC beams to validate against the laboratory test results. The results of the finite element model show good agreement with that of the experimental beams.

Mansur et. al. [18] summarized the analysis and designs of such beams under the most commonly encountered loading case of bending and shear. It has been shown that the design method for beams with large openings can be further simplified without sacrificing rationality and having unreasonable additional cost, and he was explained how to creating an opening in an already constructed beam and how to deal with multiple openings.

Salman et al. [19] studied experimentally the behavior of NC and HS of SCC. The program included ten specimens, in which the ratio a/d, steel fiber (Vf) amount, and f'c were varied. All specimens had the same main reinforcement and dimensions. They all were under concentrated vertical loading only. According to the results, it was concluded that: 1- The increase in f'c decreases deflection values. 2- With increasing f'c by approximately 93%, the cracking load and ultimate load improve by about 29% - 46% and 52% - 71%

for normal strength self-compacting concrete (NSCC) and high strength self-compacting concrete (HSCC), respectively. 3- Due to presence of steel fibers, the improvement in the cracking capacity of self-compacting reinforced concrete corbels is larger than the improvement caused by increasing f'c.

Al-Shaarbaf et al. [20] investigated experimentlly the behavior of reinforced concrete corbels under repeated vertical loadings by casting and testing twenty-four vibrated and SCC corbels with NC and HSC. All corbels had the same main reinforcement. Twelve of these specimens were subjected to monotonic loading until failure with different a/d, amounts of the horizontal stirrups, strength values of concrete including NC and HSC and the types of concrete including vibrated and SCC. It was concluded from the results that the horizontal stirrups have an insignificant effect on cracking and ultimate loads of corbels with HSC as compared with NSC.

3. CONCLUSION

The strength of RCC beam depends upon various factors which includes material type, steel reinforcement. The use of CFRP and GFRP can significantly enhance flexural strength of RCC beam. The incorporation of any type of opening reduces the flexural strength and post-cracking stiffness. Various numerical studies are conducted on RCC beam with GFRP and CFRP and the results have shown that thickness of composite material sheets can cause variation in strength of RCC beam.

REFERENCES

[1] Saksena NH, Patel PG (2013) Experimental study of reinforced concrete beam with web openings. Int J Adv Eng Res Stud Jaers

[2] Vengatachalapathy V, Ilangovan R (2010) A study on steel fibre reinforced concrete deep beams with and without openings. Int J Civ Struct Eng 1(3):509

[3] Amin HM, Agarwal V, Aziz OQ (2013) Effect of Opening size and location on the shear strength behavior of RC deep beams without web reinforcement. Int J Innov Technol Explor Eng (IJITEE) 3(7):28–38

[4] El Maaddawy T, Sherif S (2009) FRP composites for shear strengthening of reinforced concrete deep beams with openings. Compos Struct 89(1):60–69

[5] Diggikar R, Mangalgi S, Harsoor R (2013) Behavior of RCC Beam with Rectangular opening Strengthened by CFRP and GFRP sheets. In: International conference on recent innovations in civil engineering

[6] Ali AY, Ibrahim AA, Yousif RF (2011) Analysis of reinforced concrete beams with openings and strengthened by (CFRP) laminates. Univ Babylon Mag 19(3):1098–1113

[7] Chin S, Shafiq N, Nuruddin M (2011) Strengthening of RC beams containing large opening at flexure with CFRP Laminates. World Acad Sci Technol 60:12–25

[8] Vuggumudi S (2013) Experimental study on shear strengthening of RC T-beams with web openings using FRP composites. Department of Civil Engineering, National Institute of Technology, Rourkela, Odisha, India

[9] Mahmoud AM (2012) Strengthening of concrete beams having shear zone openings using orthotropic CFRP modeling. Ain Shams Eng J 3(3):177–190

[10] Al-Shaarbaf I, Al-Bayati N, Al-Kaisy D (2007) Nonlinear finite element analysis of reinforced concrete beams with large opening under flexure. Eng Technol 25(2):210–228

[11] Hawileh RA, El-Maaddawy TA, Naser MZ (2012) Nonlinear finite element modeling of concrete deep beams with openings strengthened with externally-bonded composites. Mater Des 42:378–387

[12] Amiri S, Masoudnia R, Ameri MA (2011) A review of design specifications of opening in the web for simply supported RC beams. J Civ Eng Constr Technol 2(4):82–89

[13] Fahmy EH, Hassanein AA (2002) Analysis of composite beams with web opening. In: 4th structural specialty conference of the Canadian Society for Civil Engineering, Canada

[14] Mofidi A, Chaallal O, Shao Y (2013) Analytical design model for reinforced-concrete beams strengthened in shear using L-shaped CFRP plates. J Compos Constr 18(1):04013024

[15] Mohamed AR, Shoukry MS, Saeed JM (2014) Prediction of the behavior of reinforced concrete deep beams with web openings using the finite element method. Alex Eng J 53(2):329–339

[16] Osman BH, Wu E, Ji B, Abdulhameed SS (2016) Shear behavior of reinforced concrete (RC) beams with circular web openings without additional shear reinforcement. KSCE J Civ Eng. doi:10. 1007/s12205-016-0387-7

[17] Chin S, Shafiq N, Nuruddin M (2012) Strengthening of RC beams with large openings in shear by CFRP laminates: 2D nonlinear FE analysis. World Acad Sci Eng Technol 62:549–554

[18] Mansur M (2006) Design of reinforced concrete beams with web openings. In: Proceedings of the 6th Asia-Pacific structural engineering and construction conference (ASPEC 2006), Citeseer

[19] Salman, M M, Al-Shaarbaf, I A and Aliewi, J M, 2014. Experimental Study on the Behavior of Normal and High Strength Self-compacting Reinforced Concrete Corbels, Journal of Engineering and Development, Vol. 18, No. 6, pp.17-35.

[20] Al-Shaarbaf, I A, Al-Azzawi, A A and Farahan, R S, 2015. Experimental Investigation on the Behavior of Reinforced Concrete Corbels under Repeated Loadings, Journal of Engineering and Development, Vol. 19, No. 4, pp. 126-147.