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عنوان البحث للرسالة او الاطروحة:

Strengthening Of Lightweight Reinforced Concrete Deep Beams with Woven Carbon Fiber Fabric

تقوية العتبات الخرسانية خفيفة الوزن العميقة المسلحة والمقواة بشرائح الياف الكاربون

عناوين البحوث المستلة:

1) Effect of Shear Span-Depth Ratios on Shear Strengthening of Porcelanite Lightweight Aggregate Reinforced Concrete Deep Beams Strengthened Externally By bonded CFRP Strips
2) Finite Element Analysis of Porcelanite Lightweight Aggregate Reinforced Concrete Deep Beams Strengthened by Externally Bonded Carbon Fiber Strips

تقدير المناقشة:امتياز

Abstract | مستخلص البحث

Strengthening Of Lightweight Reinforced Concrete Deep Beams with Woven Carbon Fiber Fabric

In the present study, experimental and theoretical investigations of the behavior of lightweight aggregate reinforced concrete deep beams strengthened in shear by woven carbon fiber fabric are presented. The experimental program consists of fabricating, casting and testing sixteen porcelanite lightweight aggregate reinforced concrete deep beams with the same dimensions (1400 mm overall span length, 150 mm width, 400 mm depth) and internal reinforcement (three bars of 16mm in diameter for main bars and Φ5@ 100mm for shear reinforcement in both horizontal and vertical directions). The locally available natural porcelanite rocks are used to seek for possibility of production structural lightweight aggregate concrete. Beams are designed to satisfy the requirements of ACI 318M- 14 building Code. In order to study the shear failure modes, adequate flexural steel reinforcement is provided.

All the deep beams have been tested as simply supported beams subjected to two points loading. The study took into account the strengthening schemes with carbon fiber (CFRP). The main parameters considered in this research are: shear span to effective depth ratio ($a/d = 0.8$, 1.0, and 1.2), orientation of CFRP strips (vertical, horizontal, vertical and horizontal, and inclined), spacing between the CFRP strips (100mm and 150mm), and number of layers of CFRP strips (one and two layers).All deep beams are tested up to failure under monotonic loads.

The results reflect the effect of the strengthening system on the failure loads, cracking loads, load-midspan deflection response, and the strain developed in concrete, CFRP strips and the internal shear reinforcement. Results show that the CFRP strips have increased the load carrying capacity for the strengthened deep beams up to 50 % as compared with the

The experimental work in the lightweight aggregate concrete deep beams showed that the failure load increases as the shear span to effective depth ratio decreases. As the shear span to effective depth ratio decreased from 1.0 to 0.8, the percentage of increase in the ultimate load was about 24%. In addition to that, the diagonal compression strut crack of unstrenghtened control beams was changed to several diagonal cracks at mid depth within the shear span of the strengthened beams and exhibited more ductile failure modes.

The results also indicate that bonded CFRP system in the shear span was seen to delay the formation of diagonal shear cracks and provided positive restraint to the subsequent growth of cracks. The shear crack load of the beams varies from 21 to 31% of their ultimate loads. The ratios of ultimate load carrying capacity of strengthened deep beam specimens to their control unstrenghtened ones varied from 80 to 145% depending on the parameters studied.

Increasing the amount of CFRP (by increasing number of layers from one to two layers) led to an increase in the ultimate load by about 15%. However, the increase in the spacing between the strips (from 100 to 150mm) led to a decrease in the ultimate load by about 13%. Generally, the decrease in spacing between the strips with increasing number of layers improved the behavior and capacity of the deep beams.

Numerical analysis was presented in the second part of this thesis. Finite element analysis using ANSYS release program (version 15) was carried out for only selected seven deep beams. Perfect bond between the concrete and the reinforcing bars as well as between the concrete and CFRP strips was assumed to occur. The finite element analysis results were compared with those of the experimental work for the purpose of verification. Good agreement was obtained between the numerical and the experimental results. The numerical model was stiffer than the experimental results due to full contact assumptions between the concrete surface and the CFRP strips, but there is a reasonable agreement in both trend and values. The difference in the ultimate loads was less than 18%.