

EFFECT OF FIBERS IN REINFORCED  
CONCRETE DEEP BEAMS WITH WEB  
OPENING

RASHEED ABED HAMMOOD

MASTER OF SCIENCE

UNIVERSITI MALAYSIA PAHANG



## **SUPERVISOR'S DECLARATION**

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Master of Science.

---

(Supervisor's Signature)

Full Name : DR. SHARIFAH MASZURA BINTI SYED MOHSIN

Position : SENIOR LECTURER

Date : 23 NOVEMBER 2020



## **STUDENT'S DECLARATION**

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

A handwritten signature in black ink, appearing to be 'RASHEED', is written over a horizontal line.

(Student's Signature)

Full Name : RASHEED ABED HAMMOOD

ID Number : MAC17003

Date : 23 NOVEMBER 2020

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WITH WEB OPENING

RASHEED ABED HAMMOOD

Thesis submitted in fulfillment of the requirements  
for the award of the degree of  
Master of Science

Faculty of Civil Engineering Technology  
UNIVERSITI MALAYSIA PAHANG

NOVEMBER 2020

## ACKNOWLEDGEMENTS

Firstly, all praise and thank to Allah (Azza wa jalla) for His divine guidance and help in completing this thesis.

It is a pleasure to thank those who made this thesis a reality.

First of all, I would like to express my sincere gratitude to my supervisor Dr. Sharifah Maszura Binti Syed Mohsin for her invaluable guidance, continuous encouragement and constant support all the time of research and writing of this thesis. Without his thoughtful encouragement and careful supervision, this thesis would never have taken shape. She always willing to provide me with much needed knowledge in civil Engineering. Moreover, I would also like to express my appreciation to my supervisor for being patience and tolerance in dealing my mistakes during the completion of my research.

Secondly, I would like to express my gratitude towards my brothers and sisters and my family members, especially my brothers who is my strongest supporter in the family for all form of support they have provided me to complete this research. The strong support they have provided has propelled me to completion of this research.

Thirdly, my sincere thanks go to all my colleagues and members of the staff of the Civil Engineering Department, who helped me in many ways. Many special thanks go to the members of Concrete Structure Laboratory group University Malaysia Pahang for their excellent cooperation and supports during this study.

Last but not least, I would like to say my appreciation to everyone who has given cooperation and support during the research.

## ABSTRAK

Bukaan dalam rasuk konkrit bertetulang sering diperlukan untuk menyediakan saluran untuk saluran utiliti yang menampung perkhidmatan penting seperti bekalan kuasa, bekalan air, penyaman udara dan pembedungan. Pembukaan mempunyai keperluan praktikal tetapi mereka mempunyai kesan negatif terhadap tingkah laku struktur. Kajian ini bertujuan untuk mengkaji prestasi struktur gentian dan analisis kesan kandungan gentian dalam rasuk konkrit bertetulang dengan pembukaan web. Pembolehubah ujian adalah pembukaan web yang berbeza. Pembukaan adalah satu persegi dengan ukuran 150 mm x 150 mm dan satu segi empat tepat dengan saiz 300 mm x 150 mm yang terletak pada kedua-dua rentang pertengahan atau rentang akhir rasuk yang dalam. Dua jenis gentian yang dipertimbangkan dalam kajian ini termasuk gentian keluli dan hibrid (50% keluli-50% kenaf). Empat puluh dua rasuk dalam dgn sokongon mudah dengan dimensi 125 mm x 450 mm x 1200 mm dibina dan diuji untuk kegagalan di bawah beban empat titik. Salah satu rasuk yang mendalam ini diuji tanpa sebarang pembukaan web dan tanpa apa-apa penambahan gentian untuk digunakan sebagai rujukan untuk mengkaji kesan kehadiran bukaan pada rasuk yang dalam dengan pembukaan web. Serat ditambah pada pecahan isipadu 0%, 1.0% dan 2.0%. Keputusan ujian menunjukkan bahawa penambahan gentian tunggal dan hibrid untuk rasuk konkrit bertetulang yang kukuh mempunyai sumbangan yang signifikan untuk meningkatkan prestasi struktur serat dalam konkrit bertetulang gentian. Penggunaan gentian membawa kepada pertumbuhan retakan yang lebih perlahan daripada retakan pepenjuru kritikal dan meningkatkan kapasiti penyimpanan beban rasuk yang mendalam. Dari segi penyediaan bukaan di dalam rasuk konkrit bertetulang yang dalam, keputusan menunjukkan bahawa penurunan maksimum beban muktamad di antara rasuk dengan bukaan adalah kira-kira 33% dan 42% disebabkan oleh lubang persegi dan segiempat tepat di hujung ujung, masing-masing perbandingan kawalan jauh rasuk tanpa membuka. Dari segi serat keluli tunggal, keputusan menunjukkan peningkatan ketara prestasi struktur konkrit dalam konkrit bertetulang dengan pembukaan persegi dan segi empat tepat pada pertengahan dan akhir adalah kira-kira 111%, 132%, 46% dan 72%, masing-masing dengan  $V_f = 1\%$  daripada gentian keluli, manakala dengan  $V_f = 2\%$  gentian keluli menunjukkan kira-kira 105%, 124%, 70% dan 103%. Dari segi serat hibrid, hasilnya menunjukkan peningkatan ketara prestasi struktur serat konkrit bertetulang serat dengan pembukaan persegi dan segi empat tepat pada pertengahan dan akhir adalah masing-masing sebanyak 87%, 61%, 63% dan 58%, dengan  $V_f = 1\%$  serat hybrid. Manakala dengan  $V_f = 2\%$  serat hibrid hasilnya menunjukkan peningkatan yang ketara dengan pembukaan persegi dan segi empat tepat pada pertengahan dan akhir adalah kira-kira 38%, 22%, 38% dan 40%. Penyiasatan ini telah menunjukkan rasuk dalam konkrit bertetulang dengan pembukaan web gentian tunggal dan hibrid yang digunakan untuk mendapatkan semula kapasiti rasuk yang dalam dengan yang paling ekonomi. Akhirnya, penemuan ini menunjukkan peningkatan ketara keupayaan struktur rasuk konkrit bertetulang dalam dengan pembukaan web dengan  $V_f = 1\%$  serat hibrid.

## ABSTRACT

Openings in reinforced concrete beams are often needed to provide passage for utility ducts that accommodate essential services such as power supply, water supply, air-conditioning and sewerage. The openings have practical necessities but they have negative effects on structure behaviour. The present study aims to investigate the structural performance of fibres and analysis the effect of fibres contented in the reinforced concrete deep beam with web opening. Test variables were different web opening. The openings were one square with size 150 mm x 150 mm and one rectangular with size 300 mm x 150 mm located at either the mid-span or the end span of the deep beam. Two types of fibres considered in this study included steel and hybrid (50% steel-50% kenaf) fibres. Forty-two simply supported deep beam with dimensions of 125 mm x 450 mm x 1200 mm were constructed and tested to failure under four-point loading. One of these deep beams was tested without any web opening and without any addition of fibres to serve as a reference to study the effect of the presence of openings on deep beams with web opening. The fibres were added at the volume fractions of 0%, 1% and 2%. The test results indicated that, the addition of single and hybrid fibres to reinforce concrete deep beams have a significant contribution to improve the structural performance of the fibre reinforced concrete deep beams. The use of fibres leads to much slower growth of the critical diagonal cracks and enhances the load-carrying capacity of the deep beam. In terms of provision of openings in web of reinforced concrete deep beams the results showed that the highest reduce in ultimate load among beams with openings was about 33% and 42% due to the square and rectangular openings at end span, respectively comparison of control deep beam without opening. In terms of single steel fibre the results showed that the significant enhancement of the structural performance of reinforced concrete deep beams with square and rectangular opening at mid and end span was about 111 %, 132%, 46% and 72%, respectively with  $V_f = 1\%$  of steel fibre, meanwhile with  $V_f = 2\%$  of steel fibre was showed about 105 %, 124%, 70% and 103%, respectively. In terms of hybrid fibre the results was a significant enhancement of the structural performance of fibre reinforced concrete deep beams with the square and rectangular opening at mid and end span was about 87 %, 61%, 63% and 58% respectively, with  $V_f = 1\%$  of hybrid fibre. While with  $V_f = 2\%$  of hybrid fibre the results showed the significant enhancement with the square and rectangular opening at mid and end span was about 38 %, 22%, 38% and 40%, respectively. This investigation demonstrated the ability of reinforced concrete deep beams with web opening using single and hybrid fibres to regain the deep beams capacity, using most economical resources (eco-friendly). Finally, the finding exhibited a significant enhancement of the structural capacity of reinforced concrete deep beams with web opening with  $V_f = 1\%$  of hybrid fibre.

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