FLEXURAL PERFORMANCE OF BUILT-UP COLD-FORMED STEEL BEAM (CFSB) FILLED WITH CONCRETE

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SUPERVISOR'S DECLARATION

We hereby declare that We 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.

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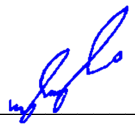
STUDENT'S DECLARATION

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.



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ABSTRAK

Keluli terbentuk sejuk (*CFS*) menjadi lebih ketara dalam bidang pembinaan dengan kelebihan yang ketara seperti keberkesanan kos, ringan, pemasangan yang mudah, penyelenggaraan yang rendah dan rintangan kakisan, mudah diangkut, boleh dikitar semula, dan mudah fabrikasi berbanding bahagian keluli tergelek panas. Walau bagaimanapun, mod kegagalan *CFS*, seperti lengkokan tempatan, herotan, kilasan sisi, dan lengkokan global, menghalang penggunaannya dalam industri pembinaan. Oleh itu, bahagian rasuk *CFS* tertutup yang dibina telah diperkenalkan dengan bahan kos rendah seperti konkrit untuk mengurangkan mod kegagalan lengkok tempatan dan meningkatkan kekuatan dan kemuluran. Kajian terdahulu dalam bidang ini telah tertumpu terutamanya pada prestasi rasuk *CFS* dari segi mampatan, dengan aspek lenturan diabaikan terutamanya. Lebih penting lagi, analisis lentur rasuk *CFS* adalah lebih rumit dari segi reka bentuk dan bentuk mod kegagalan. Oleh itu, kajian ini bertujuan untuk menyiasat prestasi lenturan rasuk *CFS* berisi konkrit yang diketatkan dengan tiga bolt menggunakan analisis unsur terhingga 3D tak linear. Perisian ABAQUS digunakan sebagai alat unsur terhingga dalam kajian ini. Prosedur pemodelan unsur terhingga telah disahkan dengan tiga penemuan eksperimen sebelumnya berdasarkan tindak balas pesongan beban dan mod kegagalan sebelum kajian parametrik dijalankan. Keputusan unsur terhingga berdasarkan dua kajian terdahulu menunjukkan ketepatan simulasi yang munasabah bagi kapasiti beban muktamad dan mod kegagalan, maka pengesahan tercapai. Kemudian, kajian parametrik telah dijalankan dengan enam konfigurasi bolt berbeza untuk menyiasat prestasi lenturan rasuk komposit *CFS* yang diisi konkrit. Penemuan kajian parametrik mendedahkan bahawa meningkatkan jarak bolt tepi dalam rasuk komposit kepada had tertentu menghasilkan prestasi yang lebih baik. Tambahan pula, mengisi bahagian *CFS* terbina dengan konkrit menghapuskan sebarang mod kegagalan lengkokan yang dikaitkan dengan bahagian *CFS*. Sebaliknya, retakan lentur adalah mod kegagalan yang paling biasa ditemui bagi konkrit isian, dengan konkrit kecil menghancurkan di bahagian bawah lubang bolt tepi. Secara keseluruhannya, keputusan yang diperoleh dari segi kapasiti beban, mod kegagalan dan pembangunan tegasan untuk rasuk terbina *CFS* yang diketatkan dengan bolt boleh memberikan gambaran kepada para jurutera tentang pelbagai kemungkinan pada masa depan bagi komponen berbeza yang membentuk rasuk komposit serta penggunaan untuk menambah baik prosedur metodologi dalam reka bentuk komposit konkrit *CFS*.

ABSTRACT

Cold-formed steel (CFS) became more visible in the construction field with noticeable advantages such as cost-effectiveness, lightweight, easy instalment, low maintenance and corrosion resistance, easily transportable, recyclable, and easy fabrication compared to hot-rolled steel sections. However, the CFS section's associated failure modes, such as local, distortional, lateral-torsional, and global buckling, impeded their application in the construction industry. Therefore, built-up closed CFS beam sections have been introduced with low-cost material such as concrete to mitigate local buckling failure modes and enhance strength and ductility. Prior studies in this line have mainly concentrated on the performance of CFS beams in terms of compression, with the flexural aspect primarily ignored. More importantly, the CFS beam flexural analysis is more complicated in terms of design and failure mode shape. Therefore, this study aimed is to investigate the flexural performance of concrete-filled CFS beam tightened with three bolts using a 3D non-linear finite element analysis. ABAQUS software was used as the finite element tool in this study. The finite element modelling procedures were verified with two previous experimental findings based on the load-deflection response and the failure modes prior to the parametric study. The FE results based on three previous studies show reasonable simulation accuracy of the ultimate load capacity and the mode failures, hence the validation has been performed. Then, parametric study was conducted with six different bolt configurations to investigate the flexural performance of the concrete filled CFS composite beam. The findings of parametric study revealed that increasing the edge bolt spacing in the composite beam to a specific limit resulted in improved performance. Furthermore, filling the built-up CFS section with concrete eliminated any buckling failure modes associated with the CFS section. On the other hand, flexural cracking was the most common failure mode of the infill concrete, with minor concrete crushing at the bottom of the edge-bolt hole. Overall, the results obtained in terms of load capacity, failure modes, and stress development for the CFS built-up section beam tightened with bolts can provide engineers with insight into the various future application possibilities of these different components forming the composite beam and utilization for improving the methodological procedures in the CFS-concrete composite design.

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