Effects of perforations on load carrying mechanism of perforated hollow sections inspired by nature

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5. Report

5.1 Proposed Executive Summary

Sustainability in built environment has currently attracted more attention, effort to increase efficiency of materials and elements used in construction becomes more important. Structural members in construction should be made more efficient in terms of the ratio of load carrying capacity to self-weight without compromising the safety of the structure as a whole. Such effort will lead to more efficient use of material and thus saving in natural resources. In this respect, nature offers a lot of idea to be copied and explored for the purpose of finding lighter and more efficient structural members. Particular aspect of idea from nature that this research study attempts to investigate is perforation over wall of hollow structural member. This research proposal is aimed at investigating how the load carrying capacity of hollow structural members is affected by perforations. This study is inspired by hollow skeleton of cactus with specific pattern of perforation and certain geometrical shape. Taking idea from skeleton of cactus, how pattern and shape of perforation affect axial, bending and torsional carrying capacity of hollow structural elements will be specifically investigated. Apart from load carrying capacity, effect of perforation on structural stiffness will also be studied. The efficiency of hollow structural element will be compared with hollow structural element without perforation. Computational analysis using finite element software will be first used for the purpose of the above investigation. Experimental work will then be carried out in order to evaluate accuracy of results obtained through computational analysis. This research proposal is novel in the sense that pattern and geometrical shape of perforation inspired by nature are able to yield structurally efficient hollow structural member with perforations. Fundamental understanding from this research will lead to proposal of efficient structural members.

5.2 Enhanced Executive Summary

Sustainability in built environment has attracted more attention, effort to increase efficiency of materials and elements used in construction becomes more important. Structural members in construction should be made more efficient in terms of the ratio of load carrying capacity to self-weight without compromising the safety of the structure as a whole. In this respect, nature offers a lot of idea to be copied and explored. Inspired by the Cholla cactus skeleton, this study investigates how the load carrying capacity of hollow structural members affected by perforations. Computational analysis using finite element method has been carried out for a total 12 models with different perforation patterns in order to investigate the strength and stiffness of models under compressive, flexural and torsional load cases. The results of perforated hollow sections have been compared with the control model without perforation. It is found that load carrying capacity not only influenced by change in section properties, but also by the perforations arrangement patterns and the load path before and after the loads being interrupted by the perforations where the spiral arrangement pattern has significant influence in certain load cases. Findings from this study is essential in leading to proposal of efficient structural members.