Geometry Effects on the Fire Resistance Rating of Masonry

Hamish Pope[1] and Ehab Zalok[2]

Abstract:

Masonry blocks are known to be good for thermal insulation. When exposed to the high temperatures of a fire, hollow blocks can still have a significantly long resistance to heat. The effects of conduction, convection, and radiation through hollow blocks have been studied at ambient temperatures to improve the thermal insulation; however, at elevated temperatures the heat transfer methods are not as well studied. Some experiments and models have been created to determine the horizontal heat flow through a block wall at elevated temperatures, and methods to reduce heat flow have been researched. The limitations of these studies are that they do not account for the vertical heat flow inside the cells of the blocks. When a hollow masonry wall is exposed to fire, the top of the wall is hotter than the bottom of the wall due to convection heat transfer. Since most experimental work, in the literature, deals with a single block or small masonry prisms, this vertical heat flow is difficult to study.

This paper describes the heat transfer methods in hollow concrete masonry walls and gives an explanation of standardized fire testing. The equivalent thickness method for determining masonry fire resistance is discussed, and its limitations are outlined. The paper focuses on the experimental results of a full-scale test designed to determine the effects of adding a bond beam within a masonry wall, as well as the effects of using reduced web masonry blocks. Heat transfer methods through hollow masonry walls and methods to improve thermal resistance are also discussed.

It was found that compartmentalization of hollow masonry blocks and hollow masonry walls played an important role in changing the fire resistance. The compartmentalization reduced the heat transfer via convection and radiation, and allowed for a more uniform temperature distribution. Since hollow masonry blocks are not themselves homogeneous, the surface temperature of the block is different at difference locations. The mortar, the solid web and the hollow cell all transfer heat at a different rate, which causes the surface of the masonry wall to have a non-uniform temperature distribution. It was found that at fire temperatures, heat transferred faster through the hollow cells, which is why finding methods to reduce the temperature in the hollow cells is important for improving the fire resistance of masonry.

DOI: 10.70803/001c.137893

[1] Instructor, Carlton University, Ottawa, ON, Canada hamish.pope@carlton.ca
[2] TMS Member, Ph.D., P.E., Associate Professor, Carlton University, Ottawa, ON, Canada ehab.zalok@carleton.ca