



Buckling of Radially Loaded Concrete Cylinders in Fire Condition

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Abstract

Concrete cylinders are commonly used in water treatment and sewerage plants, in the form of wells or basins. They are mainly subjected to axial compression resulting from soil lateral pressure and aqueous hydrostatic pressure, in case of the presence of a groundwater table; that is why they are mostly designed in the form of a circular hollow section. Concrete cylinders face a complicated case of loading in fire condition, as a result of material degradation in addition to thermally induced stresses. This paper studies buckling stability of that case where, a concrete cylinder is subjected to an internal fire load in addition to superimposed structural loads from the surrounding environment. The main objective of the research is to study buckling stability of concrete cylinders through identifying various structural and thermal parameters, controlling that behaviour. Finite element modelling using "Ansys 18.1" has been chosen as an approach to deal with the research problem. Twenty-five solid elements models have been prepared to study both thermal and structural behaviour of concrete cylinders in fire condition. Cylinder thickness, slenderness ratio, load ratio, and groundwater presence have been adopted as main research parameters to identify their effect on well's fire buckling endurance, in accordance with ISO 834 standard fire curve. A parametric study has been designed to study fire endurance vulnerability to cylinder thickness ranging from 50 mm up to 800 mm; diameter to thickness ratio [D/t] ranging from "10" up to "160"; full spectrum of structural load ratios; in addition to the presence of a surrounding groundwater. Outputs of the parametric study have been introduced in the form of figures, which could be used as preliminary design aids to identify buckling fire endurance as function of load ratio for various spectrums of thickness and slenderness ratios. Moreover, critical thicknesses and load ratios have been revealed.

Keywords: R.C.; Concrete Cylinders; Fire Endurance; Buckling; ISO 834.

1. Introduction

Concrete cylinders are widely used in various engineering applications, especially water treatment and sewerage facilities. The circular section has been adopted for two main reasons. The first is the type of loading, which is symmetric radial compression. The second is the modern improvement in construction technology through digging and circumferential concrete lining. Whatever the function of the cylinder is, most structures face the case of being internally empty; especially during construction. That is the case where a fire may burn up, putting into consideration that shuttering, or other combustible materials may present in the cylinder's internal space. The case becomes more complicated in case of presence of groundwater table, as concrete environment becomes hygrothermal [1]. Figure 1 represents a natural concrete cylinder surrounded by soil during filling stage, while Figure 2 shows a schematic diagram for the research problem in the form of a longitudinal section in a concrete cylinder subjected to an internal fire load.

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