

DESCRIPTION FOR THE GENERAL PUBLIC (IN ENGLISH)

Cases of fires that have occurred in civil engineering structures (Channel Tunnel - 1996, Mont Blanc Tunnel - 1999, Gotthard Tunnel - 2001), resulted in many casualties but also significant financial losses. During those fires a loss of concrete section and reduction in the load bearing capacity of elements was observed due to concrete explosive behaviour (concrete fire spalling). There are different types of concrete spalling, among others: the so-called popcorn effect, when small pieces of concrete are ejected with a popping sound, and explosive spalling, when larger concrete pieces are ejected with high energy. All cases of concrete fire spalling lead to exposure of reinforcement, which is sensitive to high temperature.

Spalling is one of the more interesting and complex phenomena occurring in concrete subjected to fire conditions. It is believed that fire spalling of concrete is triggered by water vapour pore pressure build-up inside concrete pores. The energy cumulated in a material unit is suddenly released in a similar manner like in Leonardo da Vinci's Architrone steam-powered cannon. However, the spalling phenomenon is not fully understood and several aspects of its occurrence remain unrevealed. Many factors seem to affect fire spalling of concrete and these include the material itself (reduced cement matrix porosity, the use of pozzolana additives, high moisture content, etc.), and stresses brought about by the presence of mechanical load, gradient of temperature or internal vapour pore pressure. According to available publications on the subject, spalling results from brittle fracture and delamination caused by biaxial thermal stresses in a plane parallel to the heated surface. Therefore, this complex phenomenon has not been fully understood yet, and it is difficult to predict the spalling sensitivity of concrete.

The aim of this project is to study the influence of restraint of thermal expansion on the intensity of the occurring fire spalling as well as to investigate the impact of the stress state on the nature of observed spalling type, i.e. the popcorn effect, or a sudden explosion resulting in a loss of the significant concrete element thickness. It is expected that this research will contribute to a better understanding of the mechanism of those two different forms of spalling.

To achieve this goal, the project will consist of carrying out of experimental research of concrete slab subjected to one-side heating, in which thermal dilation of heated part will be restrained. Such restraint may be introduced by unheated part of concrete, which will not experience thermal deformation. It is also possible to apply a steel frame, or external load that causes blocking of thermal expansion of concrete. In the project the parametrical analysis on the influence of these three ways of restraint of strains on nature and intensity of observed spalling phenomenon will be performed.

Explosive spalling of concrete due to high temperature is undoubtedly one of the most complex issues in civil engineering, thus further investigations on this phenomenon are of particular note. The results of proposed research will help to conclude about one of the two mechanisms of spalling occurrence in concrete, thus they will facilitate to carry out of further researches on other factors that are considered as increasing the risk of spalling, i.e. the moisture content, heating scenario, or the increase of water vapour pressure in concrete pores. Having knowledge about the effects of concrete restraint on spalling phenomenon, it will be possible to separate the material factors from the structural causes in further analysis of concrete susceptibility to spalling