Fire Scenarios in the Budapest Sports Arena

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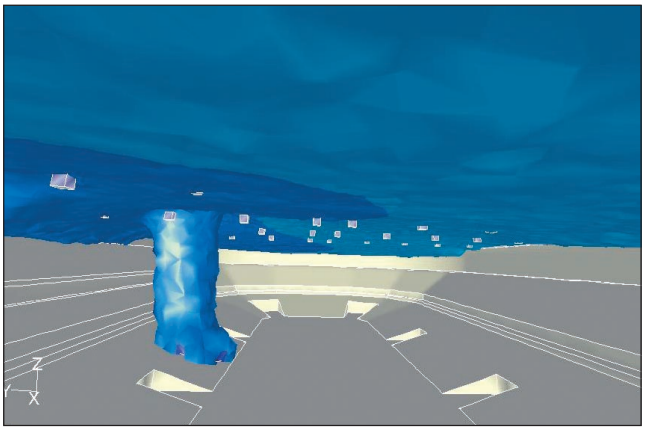
The new Budapest Sports Arena

Engineers perform a fire test inside the arena



Contours of temperature on a surface of 1% CO_2 concentration, 10 minutes after ignition, shows that the smoke has not yet reached the upper seats of the grandstands, and that the temperature everywhere on this surface is below 100°C

December 15, 1999 will forever remain in the memory of many Hungarians. On that date, the Budapest Sports Hall, the largest indoor arena in Hungary, burned down. The arena symbolized a source of great pride in Hungary. "The Hall" was where crowds could experience sporting successes and failures, World and European Cups, and many other events. The whole country was touched by the disaster. Donations were offered by artists, entrepreneurs, public figures, and thousands of private individuals.

Construction has just been completed on a new Budapest Sports Arena. Bouygues-Hungária Construction (builders of Parc des Princes and the Olympic Facilities in Sydney) was selected by the Hungarian Government as the builder for the project. The futuristic building will boast a seating capacity of 7,000 to 12,500 and an ordinary field area of 8,400m^2. Its modular design is expected to attract events such as concerts and high-profile sport competitions, including indoor motocross, horse shows, and even windsurfing.

A strong emphasis was put on safety during the design phase. In case of fire, air vents will be closed, automatic doors will open, and the smoke exhaust system will start to operate. During the early stages of the fire, the developing combustion products will rise upwards and accumulate under the ceiling of the hall, forming a continuous layer. Depending on the quantity of smoke generated and the flow rate of the smoke exhaust fans, the lower edge of the smoke layer might gradually drop down to the top rows of the grandstands. For this reason, the shape of the hall and the pace of the fire will determine the time for a safe escape, in which everyone can exit the hall without smoke poisoning or reduced visibility. An additional consideration is the distribution of temperature in the cloud of smoke, which can reduce the integrity of the building and cause radiation discomfort or injury for the spectators.

To better understand these scenarios, Bouygues-Hungária charged the Department of Fluid Mechanics of Budapest University of Technology and Economics to perform numerical simulations and wind tunnel experiments, with the goal of the former to study smoke propagation. Using FLUENT, a simplified fire model was created. The fire was initiated in the vicinity of the stage, and modeled as a simultaneous source of heat and carbon dioxide. Practical experience suggests that after ignition, the boundary of the burning area spreads at a steady velocity, and the intensity of combustion falling on a unit area is constant in space as well as in time. These phenomena were modeled with quadratically increasing sources of heat and CO_2. Since all possible fire scenarios could not be analyzed, smoke dispersion was simulated for fire cases at three different locations, by using the same power vs. time function. Thus while the simulation results provided valuable data for designers, they cannot be regarded as complete as far as all possible fire scenarios are concerned.

The FLUENT results indicate that ten minutes after the fire ignites, the smoke remains above the highest grandstand seats, so the people will have ample time to vacate the building safely. The temperature in the smoke cloud is about 100°C, suggesting that the structure will not be in danger at this time and the people will not experience too many smoke-related side-effects.

The opening of the Budapest Arena was celebrated with a large concert evening in March. ■