

## Engineering Analysis for Fire Safety Using Computational Fluid Dynamic (CFD)

**Authors :** Munirajulu M, Srikanth Modem

**Abstract :** A large cricket stadium with the capacity to accommodate several thousands of spectators has the seating arena consisting of a two-tier arrangement with an upper and a lower bowl and an intermediate concourse podium level for pedestrian movement to access the bowls. The uniqueness of the stadium is that spectators can have an unobstructed view from all around the podium towards the field of play. Upper and lower bowls are connected by stairs. The stairs landing is a precast slab supported by cantilevered steel beams. These steel beams are fixed to precast columns supporting the stadium structure. The stair slabs are precast concrete supported on a landing slab and cantilevered steel beams. During an event of a fire at podium level between two staircases, fire resistance of steel beams is very critical to life safety. If the steel beam loses its strength due to lack of fire resistance, it will be weak in supporting stair slabs and may lead to a hazard in evacuating occupants from the upper bowl to the lower bowl. In this study, to ascertain fire rating and life safety, a performance-based design using CFD analysis is used to evaluate the steel beams' fire resistance. A fire size of 3.5 MW (convective heat output of fire) with a wind speed of 2.57 m/s is considered for fire and smoke simulation. CFD results show that the smoke temperature near the staircase/ around the staircase does not exceed 1500 C for the fire duration considered. The surface temperature of cantilevered steel beams is found to be less than or equal to 1500 C. Since this temperature is much less than the critical failure temperature of steel (5200 C), it is concluded that the design of structural steel supports on the staircase is adequate and does not need additional fire protection such as fire-resistant coating. CFD analysis provided an engineering basis for the performance-based design of steel structural elements and an opportunity to optimize fire protection requirements. Thus, performance-based design using CFD modeling and simulation of fire and smoke is an innovative way to evaluate fire rating requirements, ascertain life safety and optimize the design with regard to fire protection on structural steel elements.

**Keywords :** fire resistance, life safety, performance-based design, CFD analysis

**Conference Title :** ICSFSE 2022 : International Conference on Structural and Fire Safety Engineering

**Conference Location :** Zurich, Switzerland

**Conference Dates :** January 14-15, 2022