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DEPARTMENT OF CIVIL, CHEMICAL, ENVIRONMENTAL AND MATERIALS ENGINEERING

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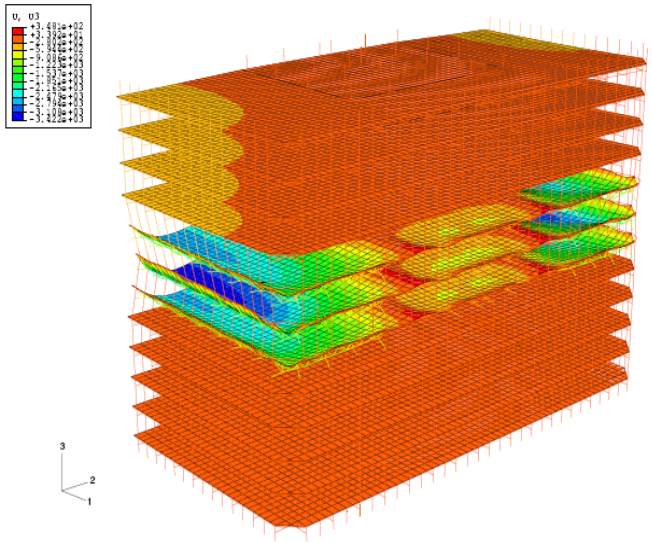
Simulation of the response of structures to large fires

Seminar: Friday 12th June 2015, 11.30 a.m., auletta LAMC, ground floor of DICAM, School of Engineering and Architecture, University of Bologna, viale Risorgimento 2, Bologna

At its barest minimum, fire regulations require buildings to be designed to possess adequate *fire resistance* so that in the event there is sufficient time available for occupants to be safely evacuated and emergency responders to conduct their intervention and rescue operations safely. This simple sounding statement hides enormous complexity and gets compounded further if applied outside the narrow bounds of structural systems covered by building regulations, such as tall buildings or bridges.



In current practice the provision of structural fire resistance is most commonly achieved by relying on simplified prescriptive approaches requiring almost no quantitative analysis. However such approaches are recognised to result in expensive solutions for steel frame structures while providing no useful quantitative information on the how a structure so designed will actually respond to a fire and indeed whether it will remain safe. The reasons for this will be discussed. More quantitative performance based engineering approaches for providing fire resistance are beginning to be used increasingly for modern buildings where prescriptive approaches are not justifiable or lead to overly costly solutions. However this option is still in its infancy and requires a great deal of knowledge and expertise on part of the engineer that can only come from dedicated education, training and experience.

A brief overview of the key features of structural response to elevated temperatures as experienced by generic structural forms in a large (post-flashover) fire will be provided. The challenges and complexities of numerically modelling such responses will be discussed. This will be followed by a discussion of the collapses of the WTC towers in New York on September 11, 2001; the lessons learnt from it; and how could they be applied in modern practice. Finally research currently being carried out at the University of Edinburgh on developing an integrated, open source and free to use software tool that would allow even the smallest consulting engineering

practices to take on jobs involving performance based engineering for fire resistance through sophisticated numerical analyses.

The Speaker

Asif Usmani is Professor of Structural Engineering and Computational Mechanics and the Head of the Research Institute for Infrastructure and Environment (IIE) in the School of Engineering at the University of Edinburgh, Scotland, UK. After obtaining a Master degree in Structural Engineering from Stanford University, California and PhD degree from University of Wales, Swansea including a period of post-doctoral research in simulation of foundry casting processes using the finite element method, he moved to the University of Edinburgh. Here he took advantage of the pre-existing history fire science and fire safety engineering research and initiated the research area of "structures in fire" leading eventually to the establishment BRE Centre for Fire Safety Engineering in IIE, which is Europe's largest university based research group in this field. This work began with a UK Government funded project on modelling the full-scale Cardington Fire Tests in collaboration with British Steel (now Tata Steel) during 1996-2000. The results from this work produced a breakthrough in understanding of the behaviour of composite steel-frame structures under fire, and have led to the development of new design methods. The knowledge gained also helped explain the structural collapses of the WTC buildings on September 11th 2001 and the discovery of previously unknown collapse mechanisms of tall buildings in large fires. His recent work is focussing on developing an integrated computational environment for simulation of structures in fire on the OpenSees platform. He is also interested in the application of modelling and simulation in performance based engineering of structural resistance to fire and multiple hazards (such as fires following an earthquake or blast). His research has led to over 200 refereed publications so far.