

Applications of Structural Fire Engineering Prague, 19-20 February 2009

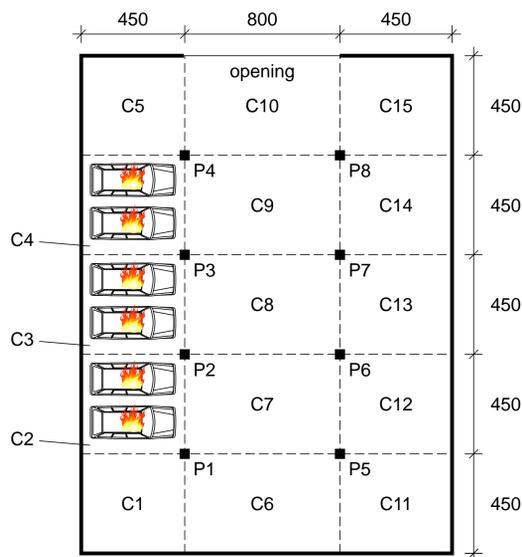


Fire Scenario and Structural Behaviour of Underground Parking Lots Exposed to Fire

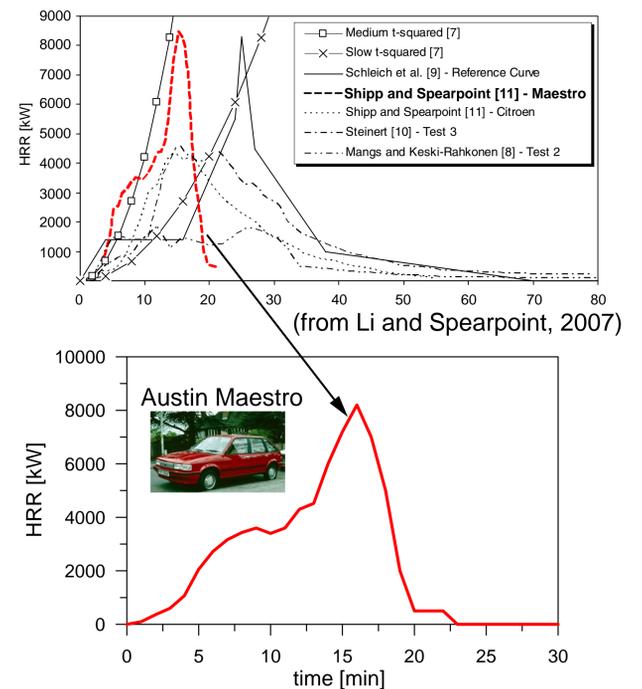
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The traffic congestion, especially in urban areas, has brought in a huge demand of parking facilities. These structures are often built underground, for lack of space, and a very common type of structure are thin flat slabs. Critical factors in the design process are surely the deformability, and the **punching shear** over the supports; the latter can become a significant problem in fire conditions, due to the increase of the axial loads on the columns.

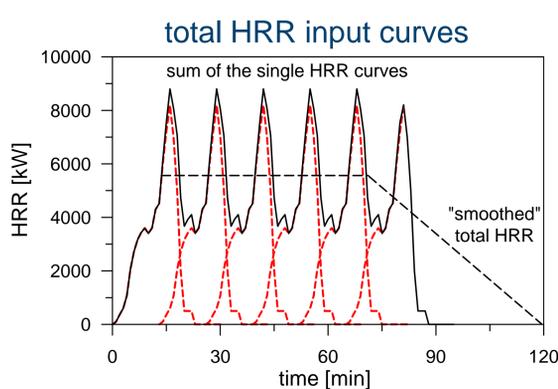
The problem was studied by considering a rectangular flat slab resting on square columns and on four perimeter walls. The columns divide the slab into a main span (8.00 m), and two minor lateral spans (4.50 m). The thickness of the slab is assumed to be 35 cm. The fire event considered is due to the ignition of 6 cars in the left aisle.



realistic fire input

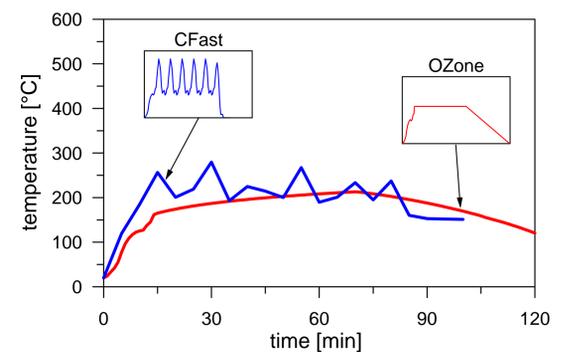
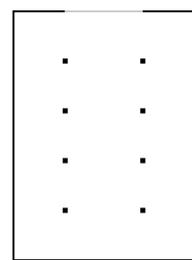


The HRR curve of the single car igniting can be used as input for the calculation: the different cars igniting are then represented as single fires, characterized by the same HRR curve, but different starting and location points. Alternatively, the total HRR curve can be input: here, it was evaluated as the sum of six HRR curves properly delayed in time (each car takes fire approximately 15 minutes after the previous one).

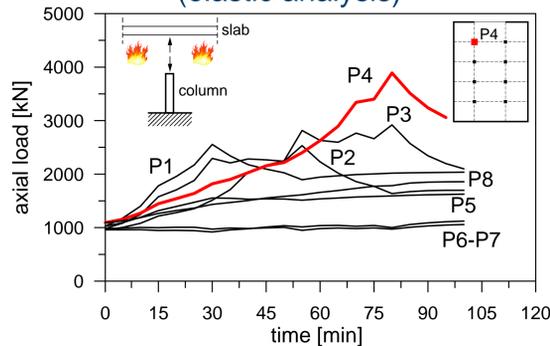


simplified analysis with two-zone models (OZone & CFast)

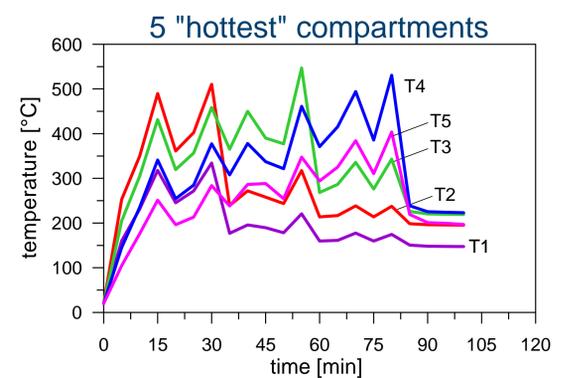
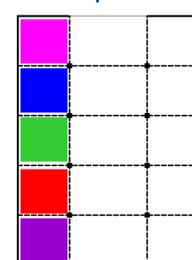
one compartment (uniform temperature distribution)



detection of the critical column = P4 (elastic analysis)

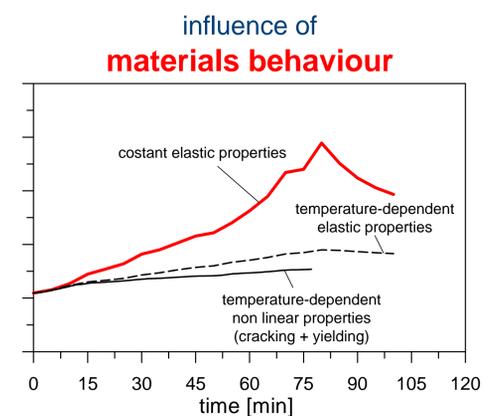
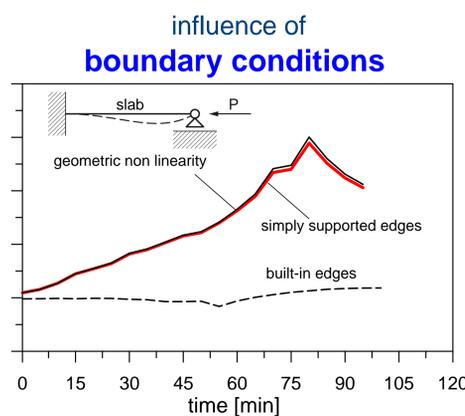
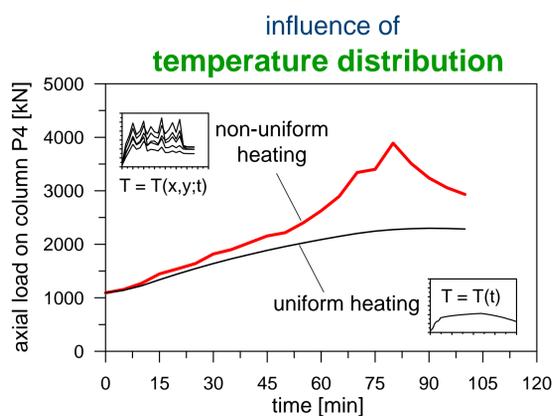


15 "virtual" compartments (NON uniform temperature distribution)



The temperature-time curves worked out can be used as input for a sequentially-coupled thermo-mechanical FE analysis.

To fully understand the structural behaviour, different analyses were carried out; the influence of the **temperature distribution**, **boundary conditions** and **materials behaviour** was investigated.



This simple example shows that in the case of a parking lot subjected to the fire of a limited number of cars, the roof slab will experience a sizable increase of the supporting actions exerted by the columns. This increase can reach significant values, if the **localized nature of car fires** is taken into account, and the structure has **no significant rotational restraints**. Taking into account **non linear materials properties** can result in a significant relief; however, an increase of the axial load as high as 50% of the value at ambient temperature is still to be expected.