

Reference study IBPSA-NVL – NIFV – TU/e

Casus 1 – Heselden case (Fire - 2D)

Description of the Heselden model and the state-values it is intended to predict (partly derived from Hegeman 2007)

Description of the flow problem

In 1971, fire tests were carried out by Heselden (Heselden 1972), in a shopping mall prior to demolition. The series of experiments were especially conducted to give a predominantly 2D (steady state) flow, and partially for this reason results from this experiment were, and still are used in several validation studies. The experimental work accomplished by Heselden already has been used by various researchers (e.g. Markatos et al. 1982) to allow comparison with results from CFD simulations.

In a room (L9×B6×H3m) in the shopping mall a fire source is placed across the full width of the room. This fire source has a width of 1.0 m. The centre of this source is positioned at 1.25 m from the rear wall. The front wall provides the ventilation opening, through which exchange with the outside environment is possible.

In the experimental set-up, the opening has a full width and a soffit with a variable height, creating various situations (see also Figure 2). In this case only an opening height of 2.0 m will be investigated (i.e. soffit height 1.0 m). The fuel used in the experiments was industrialized methylated spirit, with a heat output of 2.04 MW, calculated from the weight loss. Flame lengths, stirred up by the fire, extended to approximately half the compartment height. An ambient temperature of 293 K should be assumed. For the floor and the ceiling a fixed temperature may be assumed similar to the ambient temperature.

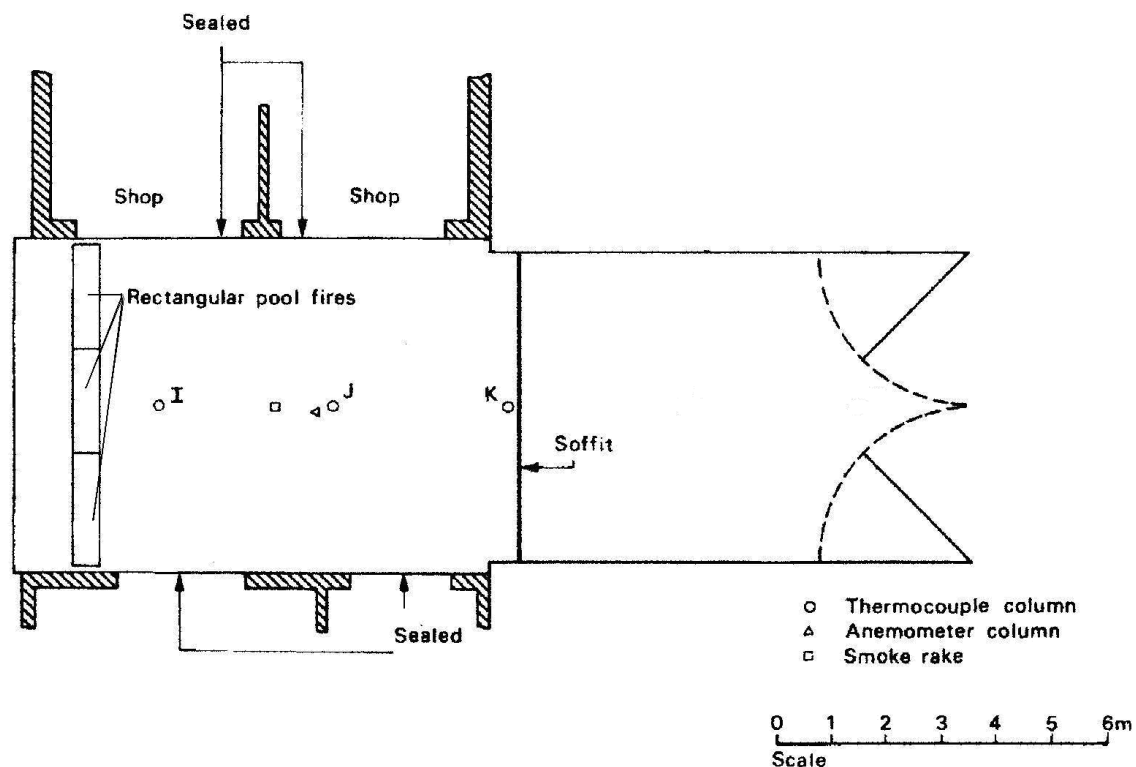


Figure 1: Plan of shopping mall showing instrumentation.

Both air temperature and air velocity were measured, using thermocouples respectively water-cooled anemometers. The thermocouples were placed along the centreline of the compartment, secured to 3

columns of 9 thermocouples each, with 0.3m vertical spacing in between. The columns were situated at positions I, J and K at 2.56m, 5.76m and 8.96m from the rear wall, respectively. Only at 5.46m from the rear wall (indicated as a triangle near position J) a velocity profile was determined, using 8 anemometers with 0.4 m vertical spacing in between. The output was sampled once every 15 seconds in case of the thermocouples, and once every minute in case of the anemometers. Also, a smoke rake was placed in order to visualize the flow and indicate any multi-layering not detected by the anemometers.

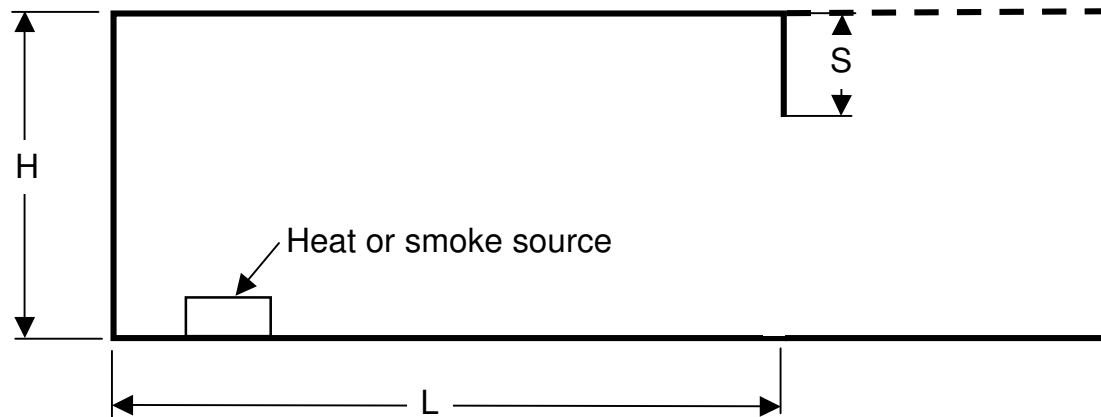


Figure 2: Side view of shopping mall.

Measurement data

Position I, $x = 2.56$ m

Height (m)	Temperature (K)
0,46	350,3
0,74	341,5
1,06	391,5
1,34	493,0
1,66	544,1
1,94	555,9
2,26	552,3
2,54	571,4
2,87	585,3

Position K, $x = 8.96$ m

Height (m)	Temperature (K)
0,46	292,4
0,74	293,8
1,05	308,7
1,34	509,1
1,65	560,0
1,93	567,6
2,53	554,0
2,85	550,3
0,46	292,4

Position J, $x = 5.76$ m

Height (m)	Temperature (K)
0,46	302,8
0,74	316,7
1,04	342,0
1,34	502,3
1,65	523,5
1,94	528,1
2,24	523,4
2,53	538,4
2,86	552,3

Triangle position, $x = 5.46$ m

Height (m)	Velocity (m/s)
0,12	-1,05
0,55	-1,08
0,92	-0,61
1,35	0,59
1,74	0,40
2,12	0,91
2,53	1,32
2,95	1,60
0,12	-1,05

References

- Heselden, A. J. M. 1972. Fire problems of pedestrian precincts. Part 1. The smoke production of various materials. Joint Fire Research Organisation, Fire Research Station. Fire Research Note 856.
- Markatos, N. C., Malin, M. R. and Cox, G. 1982. Mathematical Modelling Of Buoyancy-Induced Smoke Flow In Enclosures, Int. J. Heat Mass Transfer, Vol 25 No.1, Pp.63-75.