

CFD modelling of Ventilation in an Opera House

by ShenZhen Architecture Research Institute, China

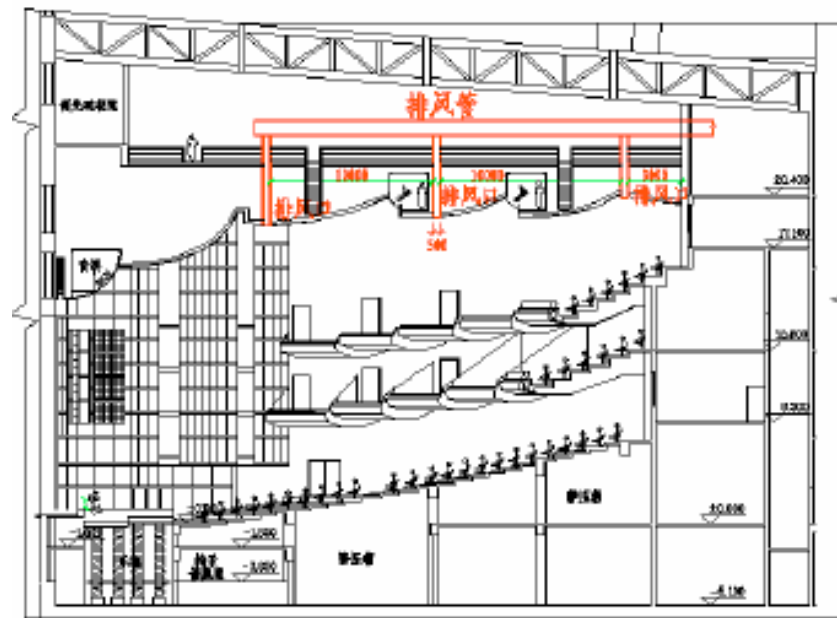
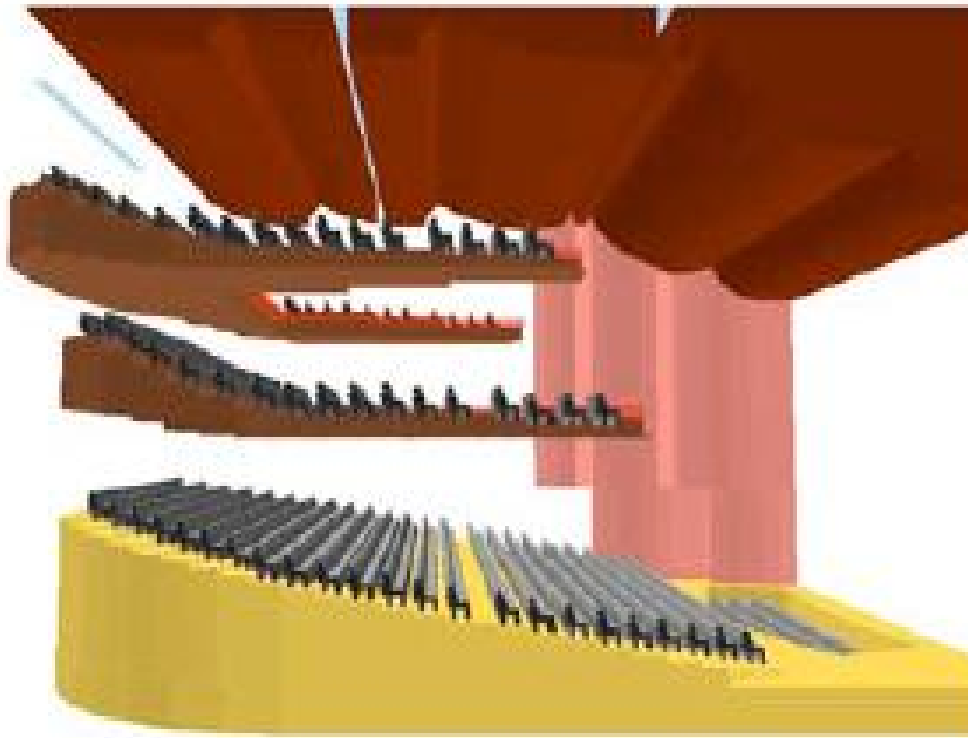


图 1 观众厅剖面图

The architectural drawing

(The ventilation pipe work is drawn in red)

The objective of the simulation is to obtain the required distribution of 23C-24C around the seating area, by varying ventilation design.



The model geometry created
with PHOENICS VR

Scenario 1

- (1) Supply air through under chairs and return air through ceiling;
- (2) Supply air rate: At the ground floor 80000 m³/h and at the first and second floor 44000 m³/h respectively;
- (3) The temperature of the supply air :21°C;

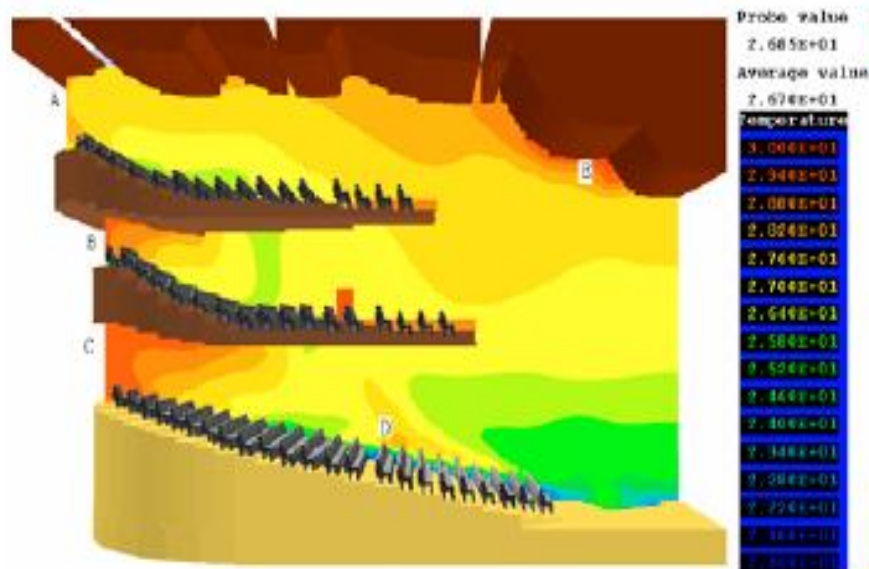


图 5 观众厅中间纵断面温度分布

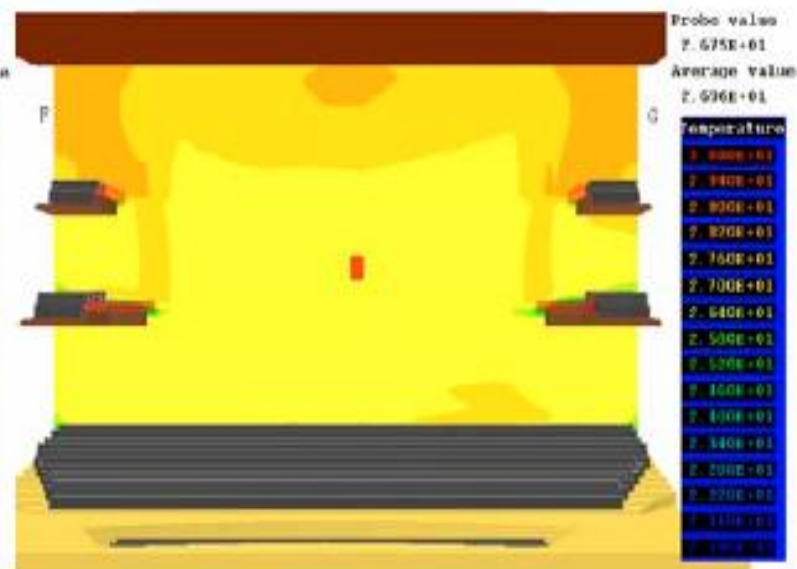


图 6 观众厅中间横断面温度分布

Scenario 2

(1) As for Scenario 1, but adding a return air exit above each of two entrance doors at the ground and the first floor respectively .

(2) The return air rate for each exit at the ground floor is 8600 m³/h, and 3600 m³/h at the first floor.

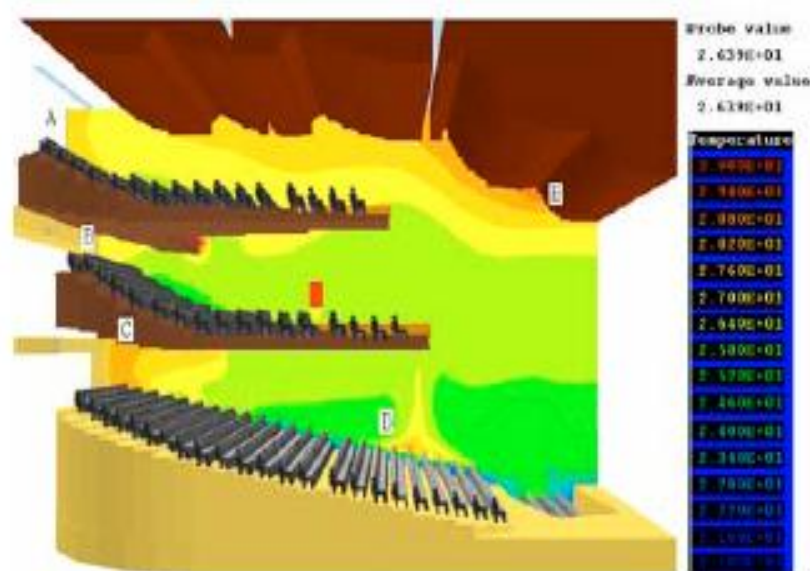


图 8 观众厅中间纵断面温度分布

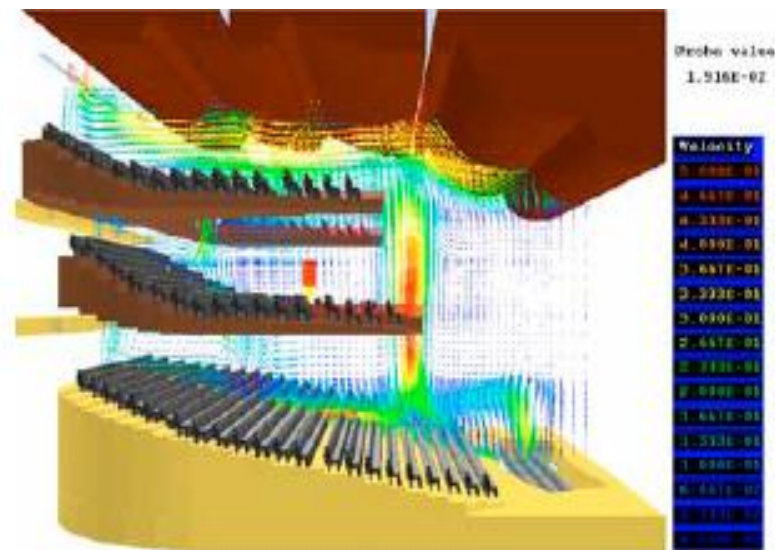


图 9 观众厅中间纵断面流速分布

Scenario 3

(1) As for Scenario 1, but adding four return air exits at the ground floor, and adding two return air exits above each of the two entrance doors at the first floor and the second floor respectively.

(2) The total return air rate is 10800 m³/h at the ground floor; the total return air rate is 7200 m³/h at the first and second floor respectively.

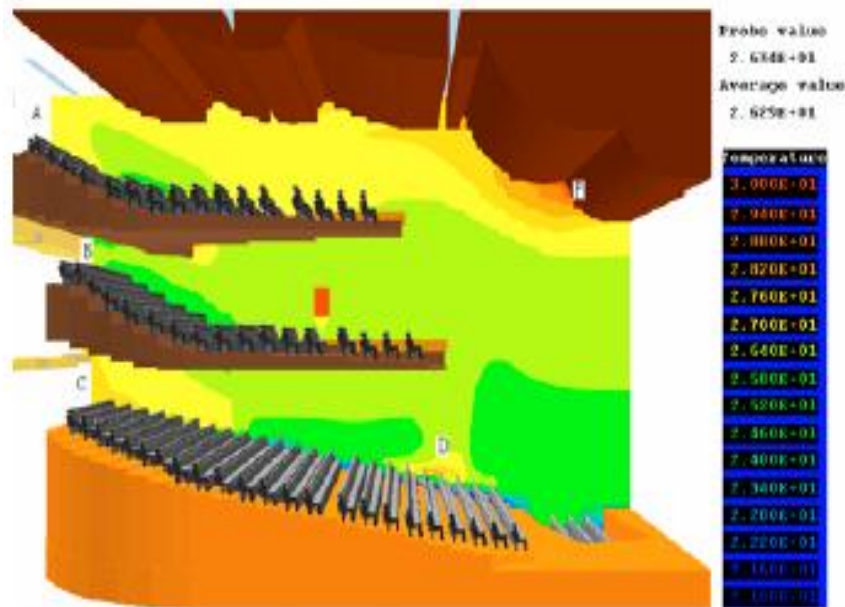


图 13 观众厅中间纵断面温度分布

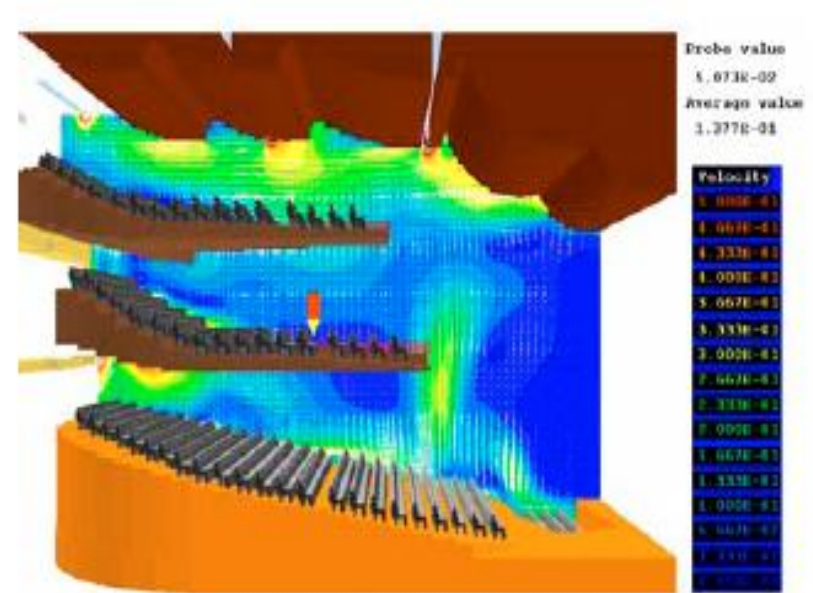


图 14 观众厅中间纵断面流速分布

Scenario 4

- (1) As for Scenario 1, but adding a return air exit above each of the two entrance doors at the ground floor, the first floor and the second floor respectively.
- (2) The total return air rate is 12000 m³/h at the ground floor; and 7200 m³/h at the first and second floor respectively.
- (3) At the same time, set up a supply air slot of 24000×10cm with the air rate of 3500 m³/h and the air temperature of 21°C.

[This ventilation arrangement meets the design requirement and produces much better temperature distribution.]

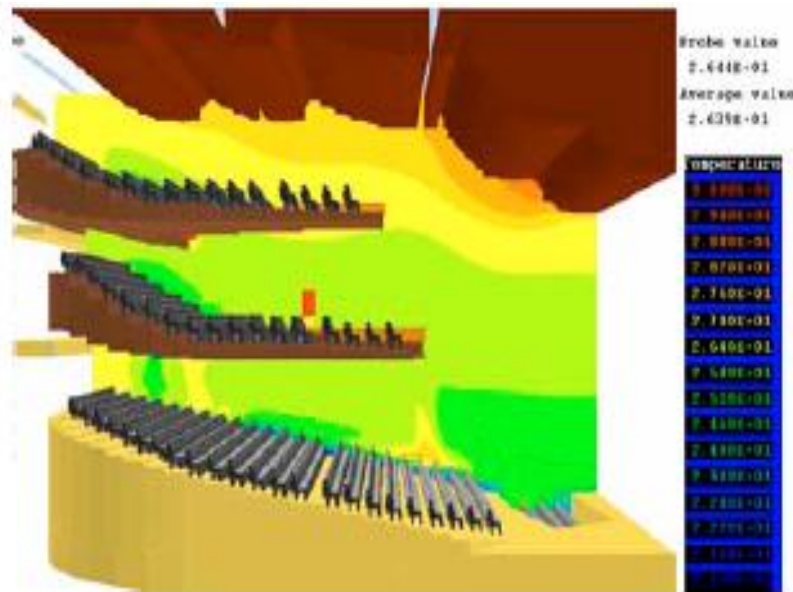


图 16 观众厅中间纵断面温度分布

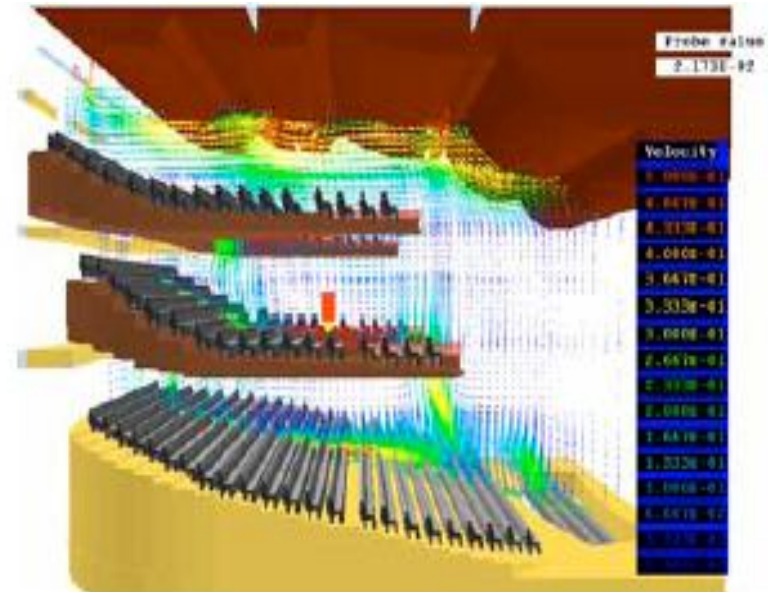


图 17 观众厅中间纵断面流速分布