# STUDYING THE EFFECT OF STREET GEOMETRY IN PARTICLE CONCENTRATION

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## OBJECTIVES

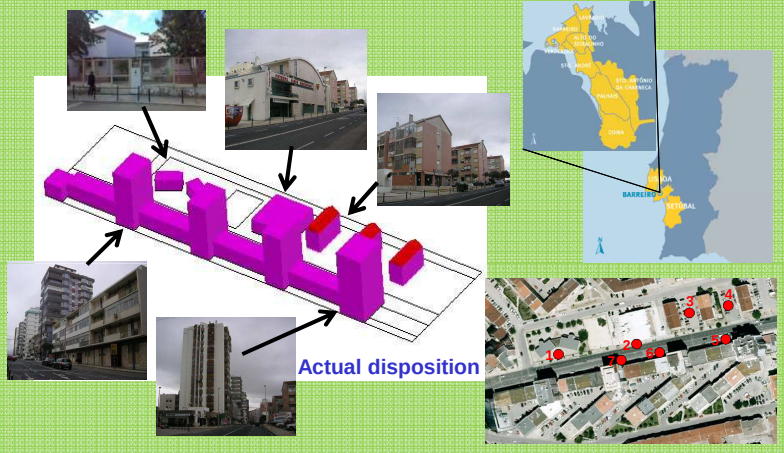
- To know influence of street geometry in the $PM_{10}$ concentration in a street in Barreiro (Portugal)
- To understand the influence that the geometry of the street plays in the in the dispersion of particles inside the street.
- To study the combined influence of the direction of the wind, the geometry of the buildings and the geometry of the roads.
- To investigate the effect of Urban Street Canyon in particle concentration.

## THE MODEL

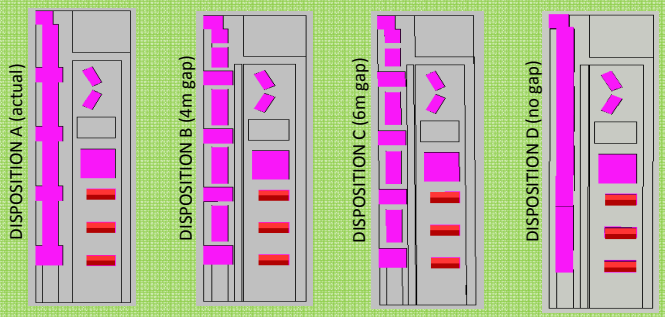
- Ansys Fluent 12.0 software was used, Workbench was used to build a thetaedrical complex grid.
- A 3D flow simulation with a Lagrangian approach was used.
- The RNG k–epsilon turbulence model was used.
- Wind profile, turbulent kinetic energy and turbulence dissipation rate was introduced as a user defined function.
- 2-way street PM10 car emission rate was considered, using the ADMS-Urban model.
- Simulation domain: 715 x 300 $m^2$ with 60200 cells

## STUDIED DOMAIN

- This study was performed in a street (Av do Bocage) of Barreiro city which is about 40km south of Lisbon, with an area of 34$km^2$ and 80000 inhabitants, with industry near the centre and heavy traffic.




## BUILDING DISPOSITION SCENARIOUS




## SOME RESULTS

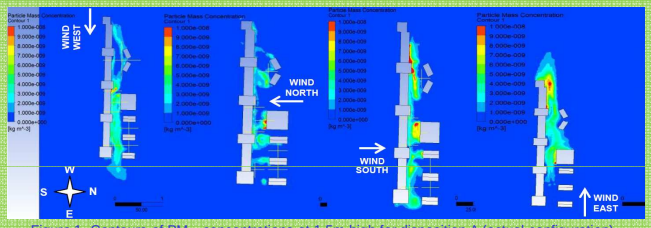



Figure 1- Contours of $PM_{10}$ concentrations at 1,5m high for disposition A (actual configuration)

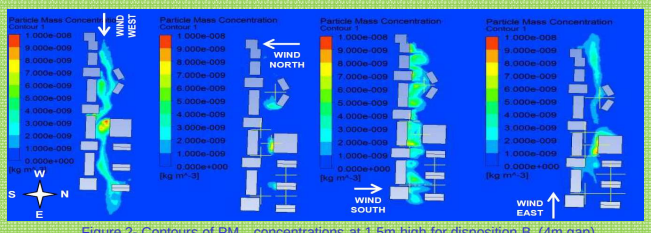



Figure 2- Contours of $PM_{10}$ concentrations at 1,5m high for disposition B (4m gap)

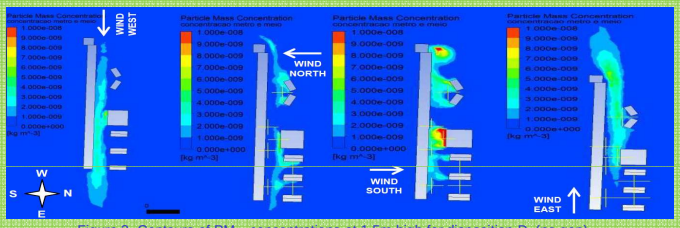



Figure 3- Contours of $PM_{10}$ concentrations at 1,5m high for disposition D (no gap)

Table 1- $PM_{10}$ concentrations at 1,5m high for disposition A (actual real configuration)

| Designation | Location | $PM_{10}$ Concentration ($\mu g/m^3$) West wind | $PM_{10}$ Concentration ($\mu g/m^3$) North wind | $PM_{10}$ Concentration ($\mu g/m^3$) South wind | $PM_{10}$ Concentration ($\mu g/m^3$) East wind | $PM_{10}$ Measurements ($\mu g/m^3$) West wind |
|---|---|---|---|---|---|---|
| Point 1 | School | 21,6 | 21,2 | 20,7 | 22,3 | 33,0 |
| Point 2 | Bingo | 23,0 | 28,6 | 27,1 | 27,0 | 31,0 |
| Point 3 | Car park(border) | 20,1 | 20,0 | 20,1 | 20,0 | 29,0 |
| Point 4 | Car park (middle) | 20,4 | 20,0 | 20,1 | 20,0 | 29,0 |
| Point 5 | High building corner | 20,5 | 20,6 | 22,7 | 20,0 | 27,0 |
| Point 6 | Residential building (east) | 22,2 | 21,5 | 21,9 | 21,0 | 28,0 |
| Point 7 | Residential building (west) | 25,0 | 20,9 | 22,5 | 20,7 | 28,0 |
| Mean value | 1,5m plane (all domain) | 20,8 | 20,5 | 21,0 | 21,1 | ---- |
| AQ Index | 1,5m plane (all domain) | 20,3 | 20,1 | 20,1 | 20,1 | ---- |

Table 2-$PM_{10}$ mean concentrations 1,5m high plane for the different configurations and wind directions

| West wind $PM_{10}$ concentrations ($\mu g/m^3$) | | | | North wind $PM_{10}$ concentrations ($\mu g/m^3$) | | | | South wind $PM_{10}$ concentrations ($\mu g/m^3$) | | | | East wind $PM_{10}$ concentrations ($\mu g/m^3$) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conf A | Conf B | Conf C | Conf D | Conf A | Conf B | Conf C | Conf D | Conf A | Conf B | Conf C | Conf D | Conf A | Conf B | Conf C | Conf D |
| 20,8 | 20,6 | 20,6 | 20,4 | 20,5 | 20,2 | 20,4 | 20,4 | 21,0 | 20,6 | 20,6 | 20,8 | 21,1 | 20,4 | 20,9 | 20,6 |

## CONCLUSIONS

- It is possible to reduce $PM_{10}$ concentrations improving the air quality in the street, only by the alteration of geometry configuration of buildings
- For west wind direction the better concentrations levels are obtained with configuration D, this geometry promotes the dispersion of pollutants as the wind is oriented with buildings.
- For north, south and east wind directions, configuration B is the one that results in lower concentrations. For these wind directions there are no visible improvements in having higher gaps (6m) between buildings instead of 4m gaps.
- The best configuration considering predominant wind direction and frequencies of occurrence is configuration B.