DESIGN AND NUMERICAL STUDY OF A CHIMNEY TO IMPROVE INDOOR AIR SUCTION USING TOPOGRAPHICAL AND METEOROLOGICAL DATABASES (BURSA CASE STUDY)

MAK492E Senior Design Project – ITU Mechanical Engineering 2016-2017 Fall Term

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Summary of Project

Using the topographical and meteorological data, the analyze of the effects of the wind in a region of Bursa was investigated to see if the relationship between chimney draft and wind. Bursa was chosen because it is the city with the number of most death cases because of CO intoxication caused by insufficient chimney draft. To do so we used mesoscale and micro scale CFD simulations over complex terrain. The mesoscale analysis in Bursa was to see at which part of the hill, the suction from a chimney is minimum. The results were implemented on a micro scale CFD analysis. To improve the chimney draft, different models for caps were simulated over the chimney. The best result was found in elongation of left sidewall vertically.

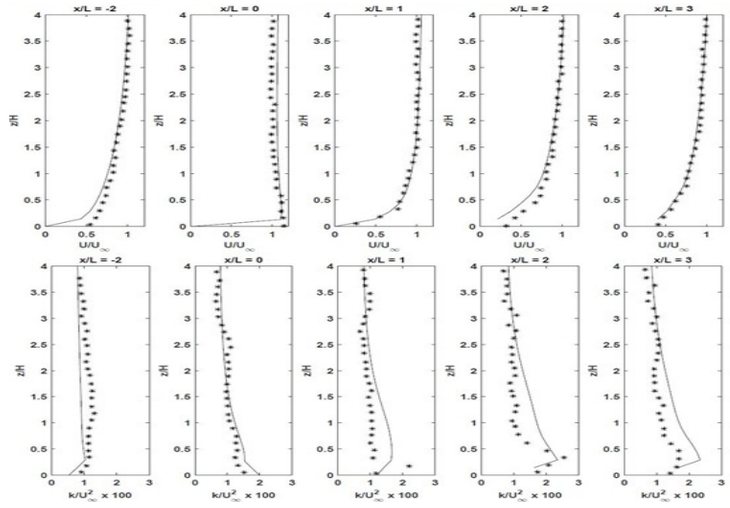
Objective

To determine the effect of a hill on chimney suction, and to design a chimney to improve the suction of the chimney.

Bursa is the city with the most cases of CO intoxication. One reason of this problem is the insufficient suction of chimneys at specific winds due to high pressure at the chimney head.

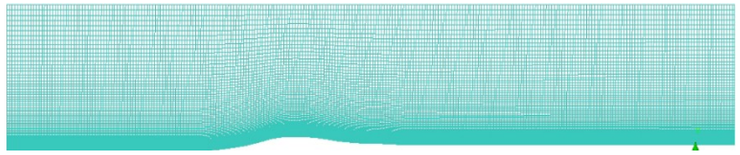
Validation of Method

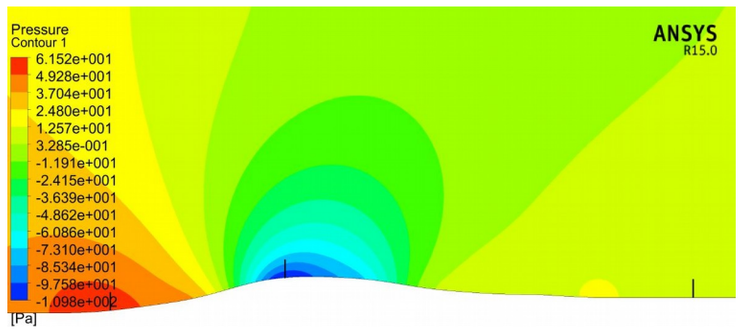
To validate the method, flow over a hill was analyzed and compared to a referance[1].The results seem to be coherent, thus, the model is accepted to be ready to be improved further for a real life case.



Simulation and Results on Bursa

A hill in Bursa was picked and numerically analyzed due to topographic and meteorologic data.



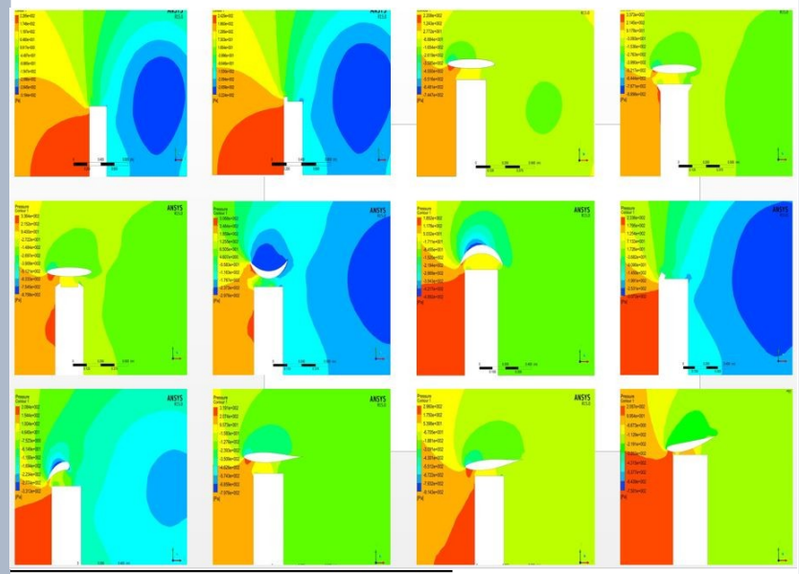


Location	Mass Flow Rate(kg/s)
High pressure	1.9743
Medium pressure	2.01201
Low pressure	2.199191

It was seen that the suction is lower at locations under high pressure while higher at the locations of low pressure.

Simulation on Chimneys and Results

11 different models were simulated and their results were obtained.



Model No	Model	$\dot{m}$ (kg/s)
0	No modification	1.9743
1	Left side wall increment	2.3689
2	Ellipse cap	0.2169
3	Ellipse cap with vertical ridge on the walls	0.165
4	Ellipse cap with horizontal ridge on the walls	0.3568
5	Crescent cap	0.1418
6	Inverse crescent cap	0.1028
7	Half Crescent cap	1.0876
8	Oblique left side wall	2.172
9	NACA4412 cap, $\alpha = 0$	0.2251
10	NACA4412 cap, $\alpha = 5$	0.276
11	NACA4412 cap, $\alpha = 10$	0.41

Best results were found as following:

-In general: Leftside wall increament added.

- With caps: NACA4412(α=10)

References

[1] Kim H.,et.al(1997) *An experimental and numerical study on the flow over two dimensional hills*, Journal of Wind Engineering and Industrial Aerodynamics, Vol.66, pp.17-33.