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Numerical Investigations of Transient Wind Shear from Passing Vehicles Near a Road Structure. Part I-Unsteady RANS Simulations

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Among elements of an intelligent transportation system for autonomous vehicles are embedded sensors for vehicle-to-structure and vehicle-to-road communications. Continuous operation of these sensors requires local electric power, especially in remote areas. Electric power sources are also needed for the structural health monitoring system, that is, for detecting any structural damage, whether natural (i.e. earthquake) or manmade (i.e. accident). Here we are providing results of part I of our unsteady numerical investigations for a generic vehicle (Ahmed body) passing under a freeway overpass at different distances from the side bridge columns. The study evaluated the wind load on the bridge columns and wind energy potential generated from the passing vehicles at different distances from the bridge columns under a typical freeway overpass that could be used for generating electricity.

Study Methods

A generic vehicle (Ahmed body) was used for our numerical simulations to understand wind flow characteristics as it passes near the bridge columns under a freeway overpass. The dimensions of the vehicle were comparable to a small passenger Van/SUV. The vehicle was spaced at 0.28 m above the road.

The control volume for the computational domain that encompasses the bridge has dimensions of X =30 m, Y = 11.25m, and Z = 14.5m with a grid size of 0.0375m. Here X is the direction of the vehicle, Y is the perpendicular distance and Z is the spanwise direction (across the road). The overpass bridge had a height of about 6.2 m. The blockage ratio, the ratio of the projected area of the Ahmed body to the projected area of the bridge underpass was less than 3%. Simulations were performed for the moving vehicle having distances of 0.75W, 1W, and

2W away from the column rows with W representing vehicle's width.

Findings

Results have shown that when the vehicle is at 0.75W distance from the bridge columns, an unsteady wind speed of up to 24 m/s is observed at the columns with a pressure coefficient difference of 0.9. These results indicate with an appropriate system for harnessing these wind energy potentials, significant renewable electricity could be generated with zero carbon footprint.

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Policy/Practice Recommendations

With the recent California Governor Newsom executive order, banning the sales of gas-fueled cars and trucks by 2035, the market will develop a higher demand for electric vehicles and, therefore, we will need additional sources of electricity. These results and our ongoing investigations provide baseline information for developing new technologies for generating electricity from moving vehicles.

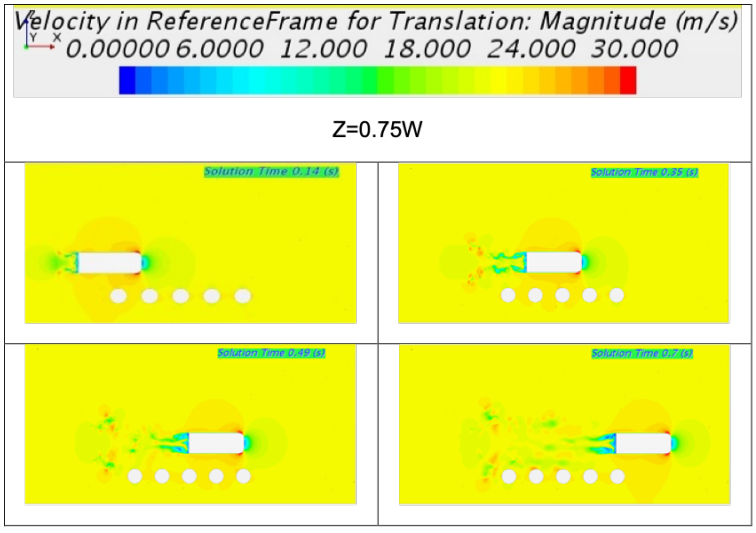

Figure 1. Contours of Mean Velocity from the Passing Vehicle

About the Authors

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To Learn More

For more details about the study, download the full report at **transweb.sjsu.edu/research/1933**

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