Fuel Cost Relief:
Promising Preliminary Results of Foundation's Fuel Consumption and Emissions Study

By Jennifer LeFevre, Program Director, RMC Research & Education Foundation

Although gasoline prices have seemed to stabilize over their record-breaking highs of $4+ per gallon in the summer of 2008, the threat of bank-breaking costs for merely driving between home and work continues to loom for millions of Americans. This is a particular concern given the still-rocky state of the economy. The country's continued dependence on foreign oil remains one of the greatest concerns for legislators and consumers alike as few solutions to this problem are readily apparent. However, the answer may not lie solely in the most commonly-referred to fixes such as making cars more fuel efficient or encouraging those who can to take masstransit to work. Real solutions to this problem must come from a variety of sources. The RMC Research & Education Foundation is contributing to the effort to solve this problem through its funding of a fuel consumption and emissions study at the University of Texas at Arlington (UTA). The study examines the role that pavements play in both fuel consumption and emissions and focuses on urban driving conditions on streets and local roads. Although the final report will not be complete until the spring of 2010, preliminary data are very promising and already demonstrate that the use of concrete pavements can make a significant difference in decreasing fuel consumption and vehicle emissions.

This isn't the first time researchers have examined the relationship between pavement and fuel consumption. Studies conducted by the Federal Highway Administration, Portland Cement Association and the National Research Council of Canada focused on fuel performance of heavy trucks on highways at high speeds. There are distinct differences in methodologies between the previous studies and the current study as well, such as a comparison between dry and wet pavement and acceleration. The results indicated a clear fuel savings through the use of portland cement concrete; this study seeks to build on those results by examining if the theory would be applicable to passenger cars driving on streets and local roads in urban areas where most fuel is consumed. Additionally, the current study will also evaluate data regarding emissions rates and will include a tool to estimate fuel consumption and emissions rates.

The CO_2 Difference

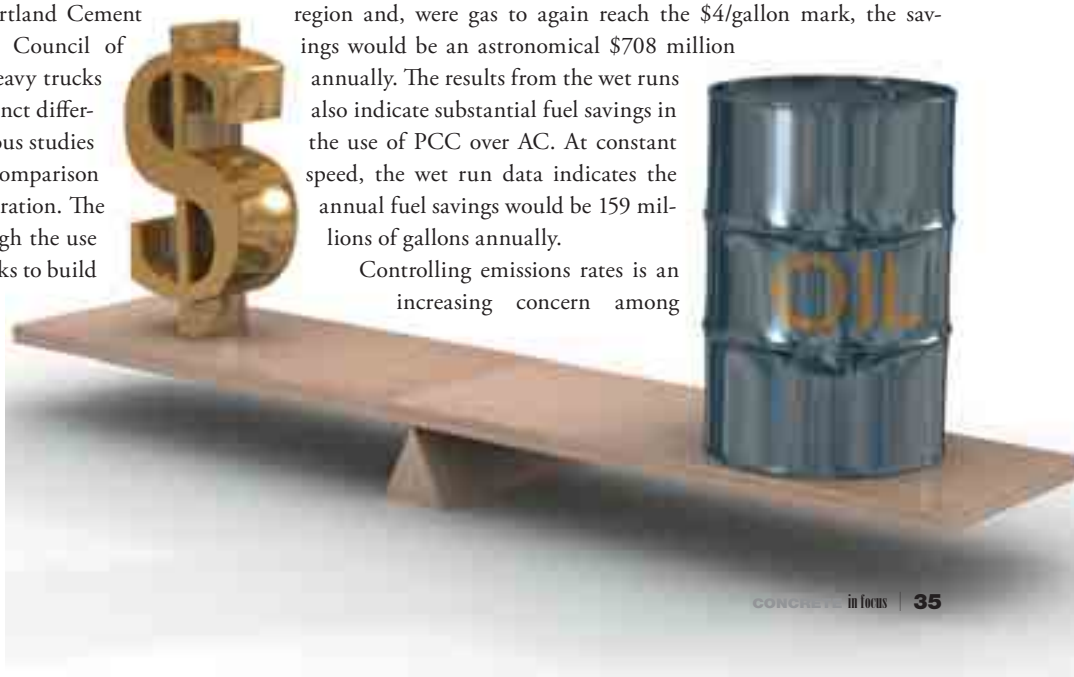
The data indicates a difference in CO_2 emissions of 0.62 million tons per year in the Dallas-Fort Worth (DFW) Region alone. The average cost of CO_2 clean-up is approximately $18 per metric ton. Therefore, the use of concrete could save approximately $11 million per year in CO_2 clean up costs in the DFW area annually, and much higher savings nationwide.

The study at UTA includes data collected from multiple runs of an instrumented passenger van driven on city streets on two pavement types: portland cement concrete (PCC) vs. asphaltic concrete (AC); in two driving modes: constant speed vs. acceleration; and with two surface ambient conditions: dry vs. wet. Other factors that may influence fuel consumption were controlled or kept the same during data collection. Variables recorded for the study include date, time, ambient air temperature, atmospheric pressure, humidity, wind speed and direction, the temperature of the fuel flowing into and out of the tank, vehicle weight, tire pressure and auxiliary devices (e.g. A/C, radio, headlights, windows).

There were eight factor-level combinations: four each for PCC and AC - constant speed-dry, constant speed-wet, acceleration-dry and acceleration-wet. There were five replicates for each factorial combination resulting in 40 runs.

The results from the dry runs at constant speed, which were conducted first, are stark. The data indicate that at a constant speed, fuel consumed on PCC is significantly lower than the fuel consumed on AC (see chart). In fact, if the annual vehicle miles of travel in the Dallas-Ft. Worth (DFW) region took place at a constant speed of 30 mph on PCC pavements, the statistically lower fuel rate could result in an annual fuel savings of 177 million gallons annually, just in the DFW area alone. With a fuel cost of $2/gallon, that would mean a savings of $354 million annually in the DFW region and, were gas to again reach the $4/gallon mark, the savings would be an astronomical $708 million annually. The results from the wet runs also indicate substantial fuel savings in the use of PCC over AC. At constant speed, the wet run data indicates the annual fuel savings would be 159 millions of gallons annually.

Controlling emissions rates is an increasing concern among



communities and the world over as the debate over global warming rages on. Areas in jeopardy of losing coveted federal highway funding due to non-attainment status for air pollution rates have an even greater stake in decreasing regional air emissions. The researchers of this study hypothesize that there is a direct correlation between pavement type and emissions and the data support that theory. On the dry runs at constant speed, the data demonstrate that total CO_2 emissions are significantly less on the PCC than on AC (see chart). In fact, the use of PCC in dry conditions can result in a reduction of 0.62 million metric tons of CO_2 annually. Some groups estimate that CO_2 clean up costs to be approximately $18/metric ton. The decrease of 0.62 million metric tons of CO_2 through the use of PCC over AC would result in a clean-up cost savings of $11 million annually in the DFW region alone. The results of the wet runs indicate a decrease of 0.56 million metric tons of CO_2 with the use of PCC, which translates into a clean-up cost savings of just over $10 million. Again, these figures are for the DFW region alone, so national savings would be much greater.

PCC = Portland Cement Concrete AC=Asphaltic Concrete	Fuel Consumed (millions gals/yr)	Total CO_2 (million metric tons/yr)
PCC, Constant Speed, Dry	3,598	12.70
AC, Constant Speed, Dry	3,775	13.32
PCC, Constant Speed, Wet	4,783	16.88
AC, Constant Speed, Wet	4,942	17.44

Note: These estimates are based on the total vehicle miles of travel in the Dallas-Fort Worth region alone

Another key element to this project will be the development of a tool for use by state Departments of Transportation and local municipalities to help them quantify the total fuel consumption and project carbon footprint over the design life of a pavement. This tool will take an estimate of the vehicle miles traveled (VMT) and the vehicle mix of the area and apply the fuel savings and carbon emissions data to help them assess how prospective projects will impact their communities with respect to these important factors. Although this project is specific to urban conditions, the tool will also be applicable to other types of roadways.

Never before has the need to reduce fuel consumption and examine emissions factors been so important. This unique time in our history demands innovative solutions for complicated problems and the RMC Research & Education Foundation is proud to be making a significant contribution to helping to identify ways communities can significantly reduce both fuel consumption and decrease emissions from vehicles. As the emphasis to evaluate and reduce the carbon footprint in all areas of life grows stronger, the RMC Research & Education Foundation will continue its commitment to supporting work that will benefit all U.S. citizens. ■

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Why Is This Study So Important?

- U.S. Gasoline Consumption was over 142 Billion Gallons in 2007 (Energy Information Administration, U.S. Department of Energy)
- Vehicular Fuel Consumption Accounts for Half of the Total Energy Consumption in the U.S. (TRB Special Report 285, 2006)
- Approximately 25% of the Total U.S. Energy Consumption Attributed to Driving on City Streets (Larson, 1992)
- Transportation Sector is the Largest Emitter of CO_2 (EIA, U.S. DOE)