Increasing the Value of Airport Pavement Management

By Michael Gerardi

- Pavement management tools promote pavement longevity
- Monitoring a pavement's profile can save money and enhance pavement life
- Case studies demonstrate advantages of profile measurement

When you have been in one industry since 1993, you can make some interesting discoveries – to have that *"ah-ha"* moment. My *ah-ha* moment was discovering the benefit gained when you measure the true profile of a runway, and then years later measure that runway profile again. When you compare that old profile data to a new set of profile data of the same runway, changes to the profile can be fairly evident. This article describes the value airports receive when they incorporate runway profile monitoring into their pavement management practices.

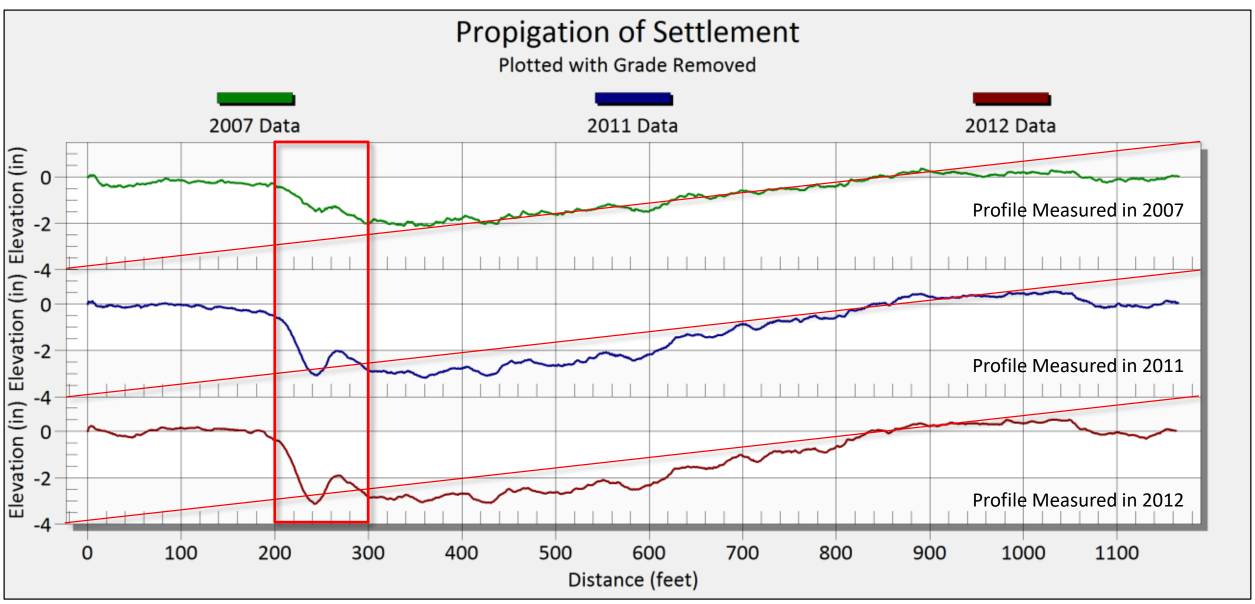
Understanding that pavement management is proactive in nature, many world-class airports are adding a new tool to their pavement management program. That new tool is runway profile monitoring. Monitoring a pavement profile over time will reveal structural changes that take place over the life of the pavement. As time passes, these profile changes can begin to affect the ride quality of the pavement by increasing the aircraft's response. This, in turn, can be the start of a destructive and costly cycle of increased dynamic loading and localized pavement failure. Increased aircraft response exerts dynamic loading on the pavement. Each aircraft that responds to an area of roughness increases the loading environment on that localized pavement. Increased loading, over time, reduces a pavement's effective service life. The old saying remains true; "smooth pavements last longer."

The answer to this problem is to monitor the pavement's profile. The key is to identify the change in profile shape and to quantify the effect those profile changes have on aircraft ride quality. For example, once differential settlement is detected, implementing an effective set of metrics to determine its effect on aircraft response is important. Once you determine that ride quality is deteriorating, repairs can then be planned. This process allows early intervention when the affected area is smallest and least intrusive to correct. The most effective way to monitor the pavement's profile is to use a device or method that can measure the pavement's true profile. That method will enable the pavement's profile to be measured initially establishing a baseline profile, and then comparing that baseline to subsequent profiles measured years later.

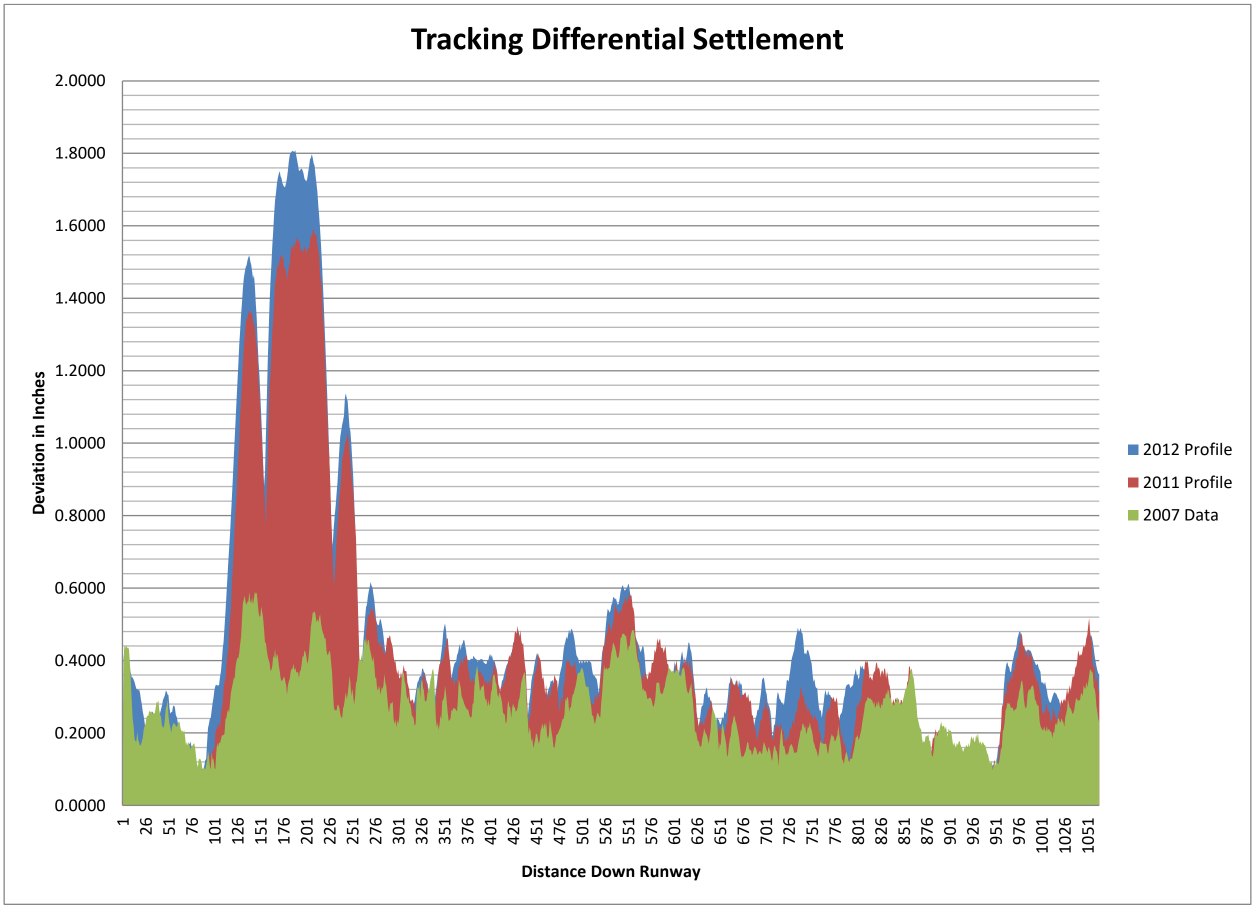
The following are two case studies that track differential settlement. As you can see, as the settlement increases, so too does the aircraft response and the dynamic loading on to the pavement.

	Year Measured	Change in Profile	Peak Accelerations and Condition Color Code
Case Study 1	2007 (Baseline)	Baseline	Pilot's Station: 0.30 G Aircraft's CG: 0.25 G
	2011	-1.51 Inches	Pilot's Station: 0.79 G Aircraft's CG: 0.55 G
	2012	-1.70 Inches	Pilot's Station: 0.88 G Aircraft's CG: 0.57 G
Case Study 2			
	2005 (Baseline)	Baseline	Pilot's Station: 0.36 G Aircraft's CG: 0.30 G
	2010	-1.71 Inches	Pilot's Station: 0.59 G Aircraft's CG: 0.56 G
	2013	-2.17 Inches	Pilot's Station: 0.64 G Aircraft's CG: 0.71 G

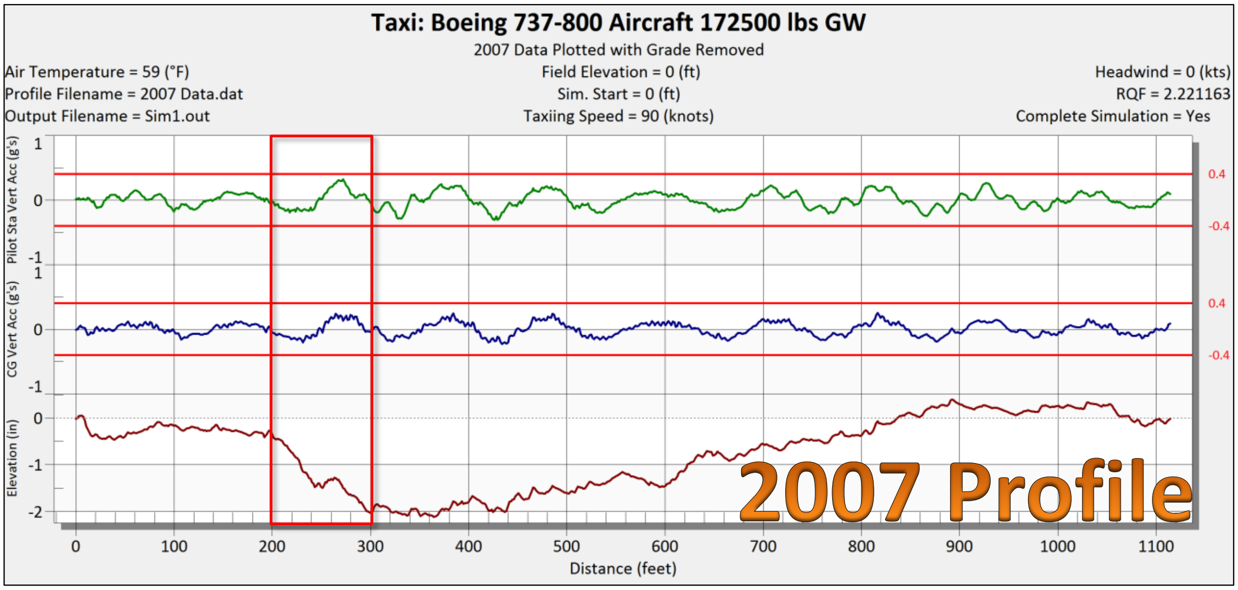
Case Study One



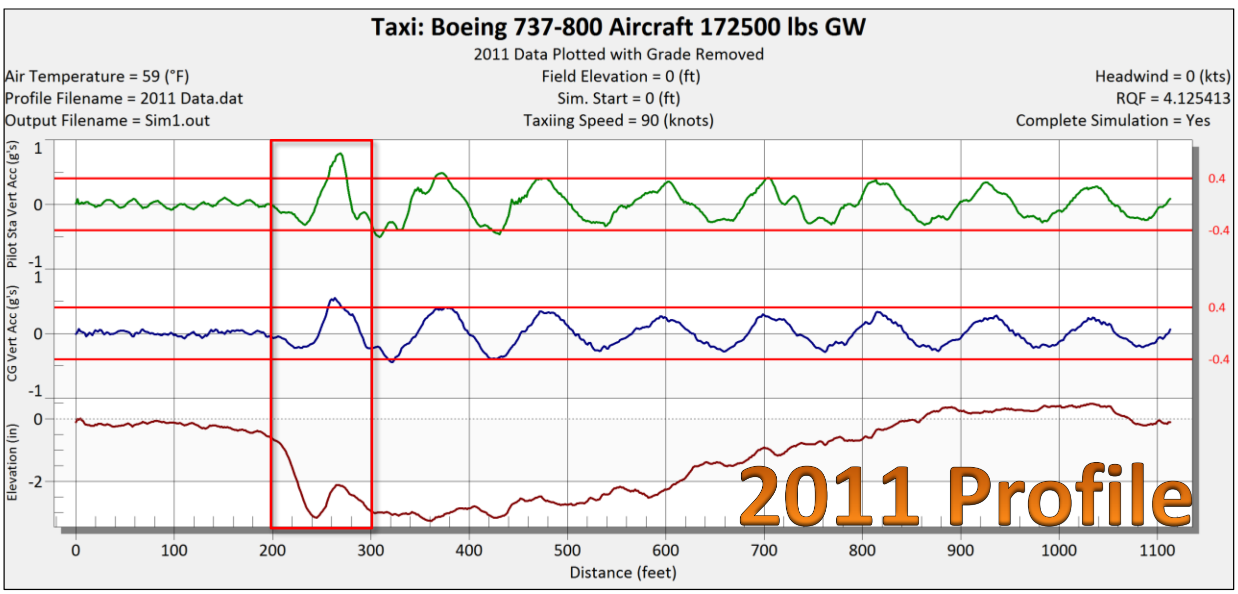
Case Study 1 illustrates that, over time, this runway has developed a dip in the runway's keel section that has been getting progressively deeper. This particular runway is an asphalt pavement built in a relatively marshy environment. This figure shows the plotted centerline profile measured at three different points in time. The top portion of the plot was measured in 2007. The middle portion of the plot was measured in 2011, and the lower portion of the plot was measured in 2012. The red diagonal line helps show the profile shape change along an 800-foot section. The primary settlement dip is located at the 240-foot point.



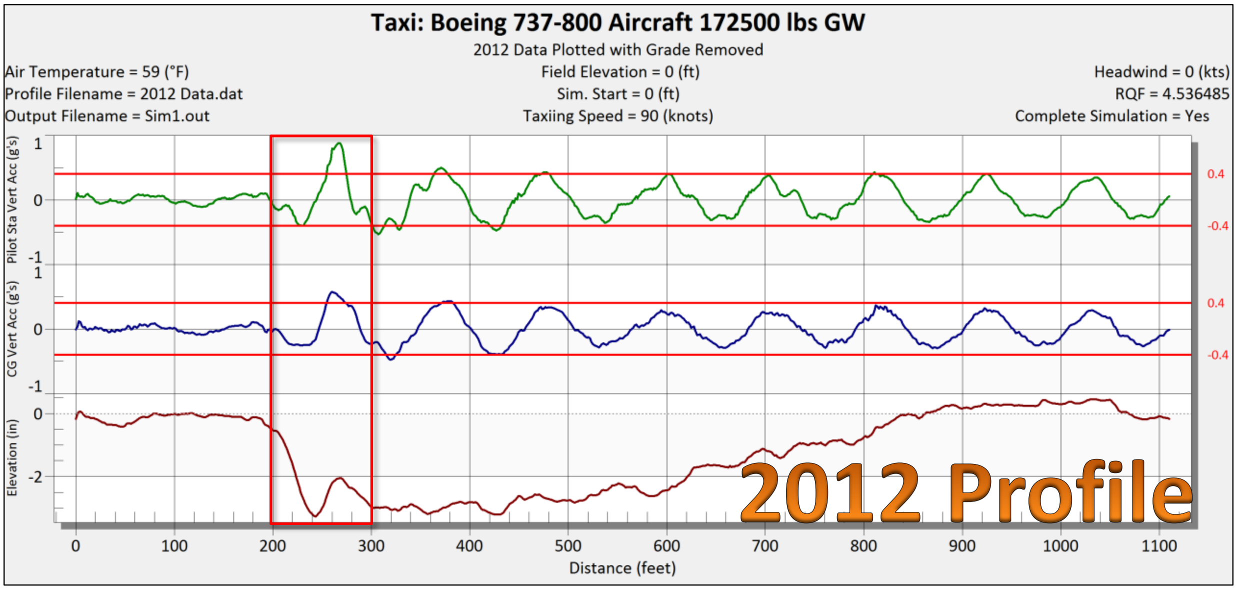
This figure plots the deviations from a straightedge for that section of measured profile. The green area plots the deviations when evaluating the 2007 profile data. The red area plots the deviations when evaluating the 2011 profile data, and the blue area plots the deviations when evaluating the 2012 profile data. This chart helps illustrate the profile's rate of change. This rate of change information is important in determining when to make pavement repairs.



Here is a plot that depicts the results of a Boeing 737-800 constant speed taxi simulation at 90 knots using the profile data measured in 2007. As you can see, the accelerations (top and middle traces on this plot) do not show any areas that exceed the .40g threshold for accelerations. In other words, the pavement had no areas of roughness in 2007.

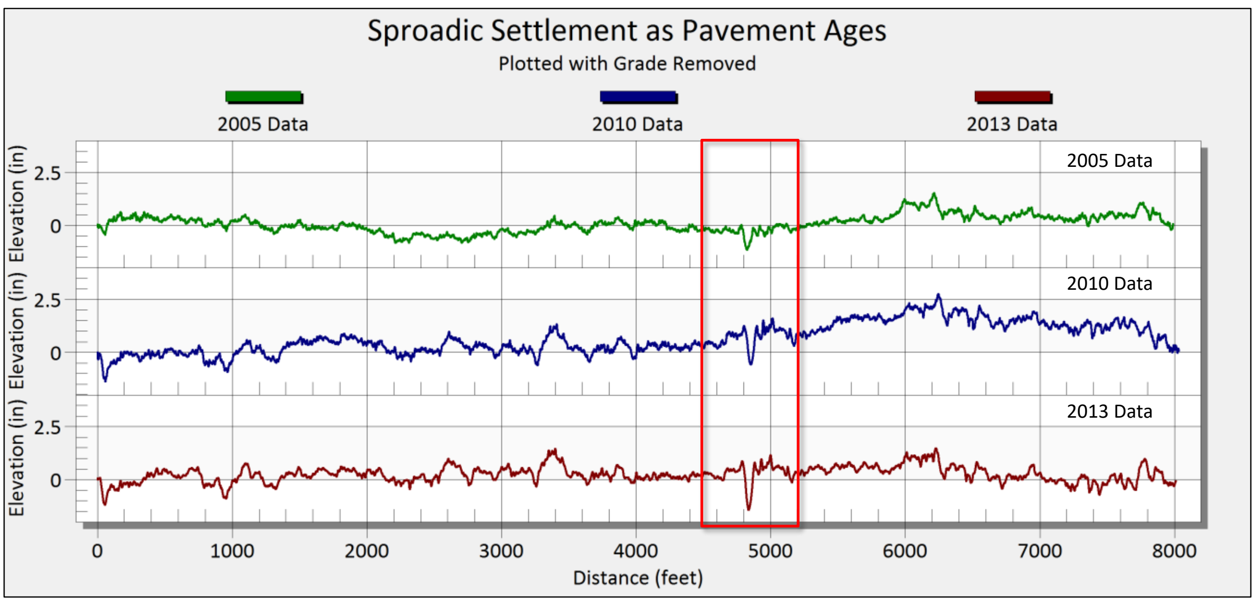


This figure depicts the same simulation (737-800 90-knot constant speed taxi test) only this time it is conducted on the profile data measured in 2011. You can see in the bottom trace that the dip is a bit deeper, and that the aircraft response is now predicted to exceed the .40g threshold of acceptability. This area is now considered to be rough.

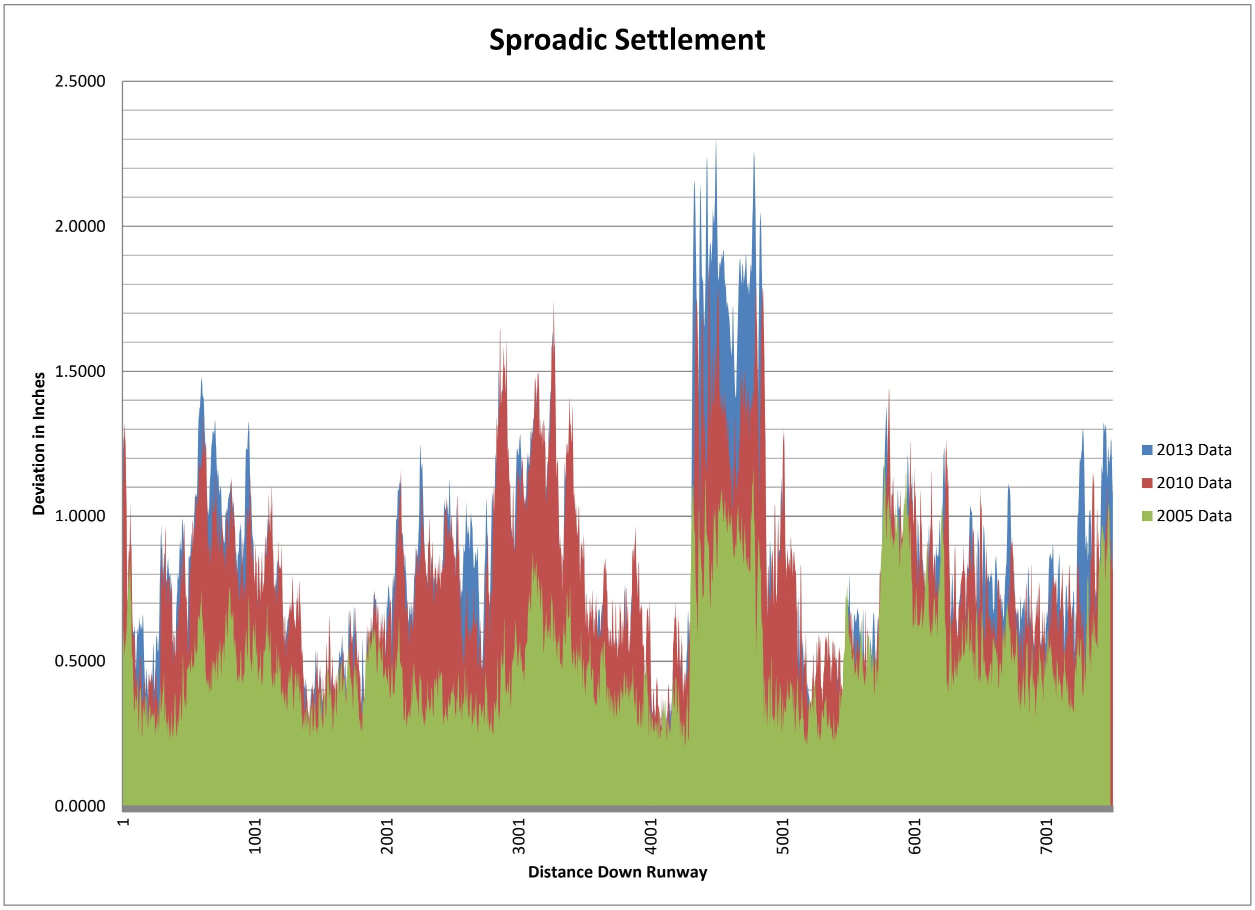


Here again, a plot of a 737-800 performing a 90-knot constant speed taxi. This time it is conducted on the profile measured in 2012. The dip is a bit deeper and the aircraft response is noticeably worse than it was in 2011.

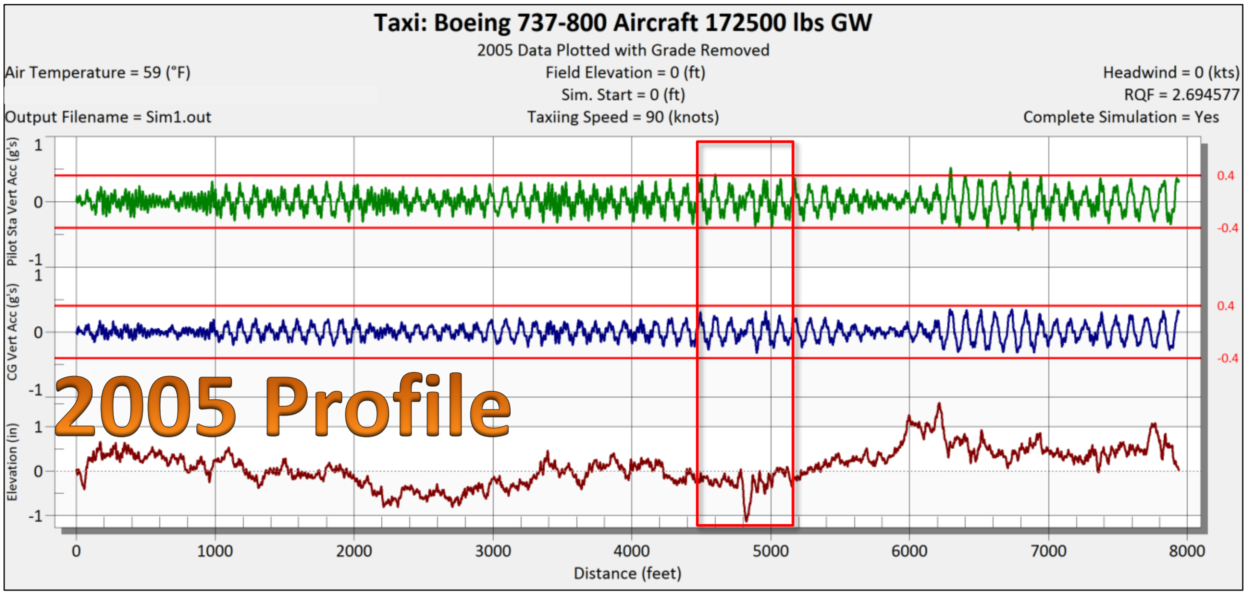
Case Study Two



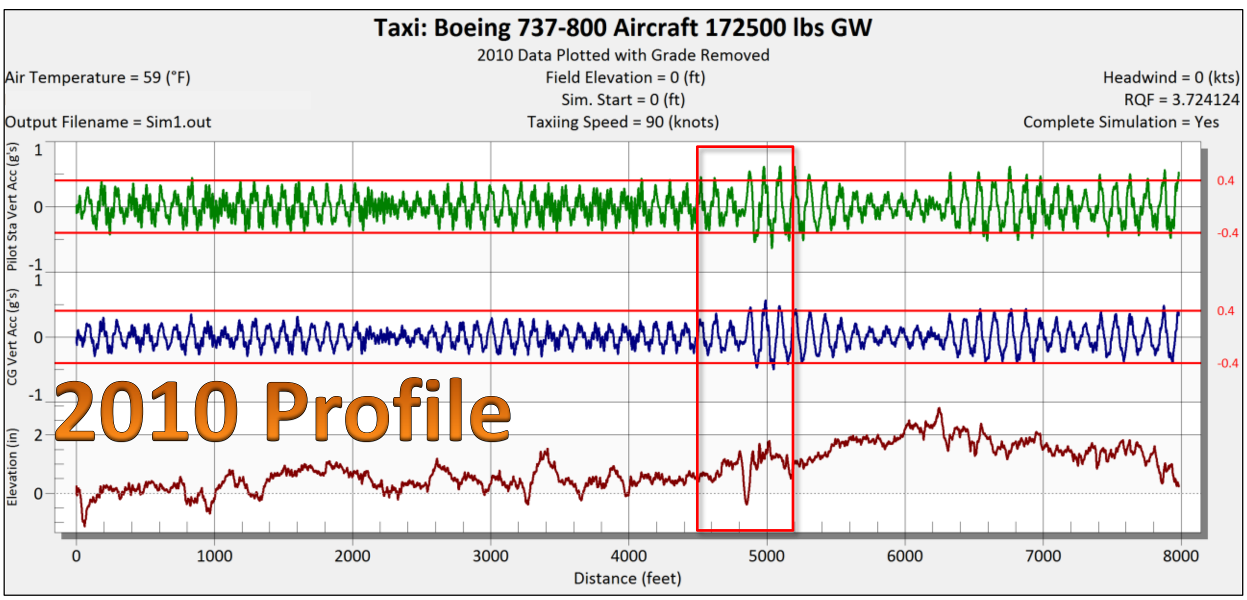
The second case study is based on a PCC runway that was constructed around 2004-2005. Profile measurement, used as a standard component of the airport's pavement management program, began to detect settlement at approximately 4,900 feet. The settlement, in this case, is due to sub-surface tunneling. This figure plots the runway's centerline profile measured at three different points in time; 2005 (top), 2010 (center) and 2013 (bottom).



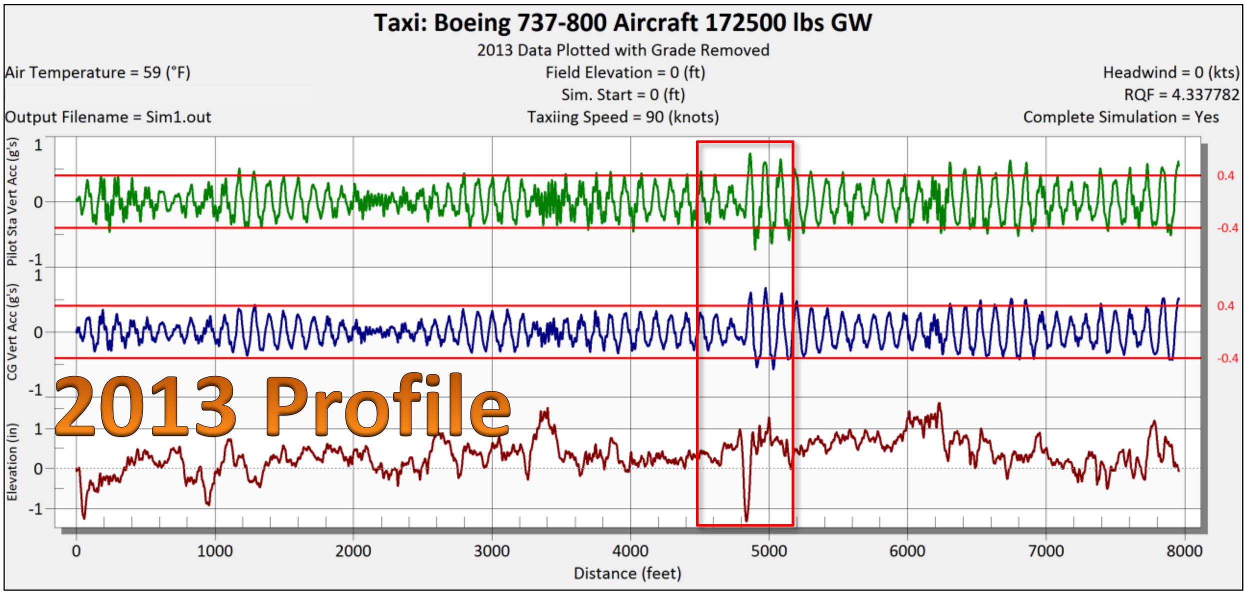
As in the previous case study, this plot helps track the rate of change when comparing the maximum deviations to a straightedge for each set of profile data. Here, you can see sporadic settlement throughout the profile. For example, when you see blue reaching higher than the red, that indicates that the deviation to the straightedge was larger in 2013 than it was in 2010. The tunneling settlement is evident between 4,000 and 5,000 feet.



This figure depicts a 90-knot constant speed taxi simulation of a Boeing 737-800 on the 2005 profile data. As you can see, ride quality through the area of settlement is predicted to be within acceptable limits.



This figure depicts the same simulation as the previous figure, only this time on profile data measured in 2010. Both the Pilot's Station Acceleration (top portion) and the Aircraft Center of Gravity Acceleration (middle portion) predict excessive response as it encounters the dip area which is increasing in depth.



This figure shows that by 2013 the dip has become dramatically deeper (bottom portion). Both the pilot's station and aircraft center of gravity predict that the aircraft response has deteriorated significantly since 2010. Increased aircraft response means that dynamic loading is increasing as well. Continued exposure to this loading environment will affect the localized pavement's useful life.