Airfield Pavement Roughness Evaluations Using Aircraft Simulation

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The Primary Reason We Strive to Build and Maintain Smooth Pavements is to Minimize Aircraft Dynamic Response and Maximize Aircraft and Pavement Performance.

Courtesy F. Seggie

Improving Aircraft Performance and Pavement Life

- APR Focuses on the Interaction Between the Pavement and the Aircraft
  - Rough Pavements Increase Pavement Loads
  - Rough Pavements Increase Wear and Tear on Aircraft
  - Pavements Profiles can Change with Time and Traffic
- APR Offers Products and Services to Help Airports Maximize their Pavement's Service Life and Maintain Safe/Efficient Air Operations

APR's Core Technology

Aircraft Simulation

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Why Aircraft Simulation

- Straightedge or Profilograph or Boeing Bump Cannot Predict Aircraft Response
- Aircraft Simulation
  - Accounts for Multiple Bumps and Dips in Succession
  - Simulates Any Operation in Any Condition
  - Multiple Commercial Aircraft Types Available
  - If Roughness Exists, Aircraft Simulation Will Identify the Event's Precise Location

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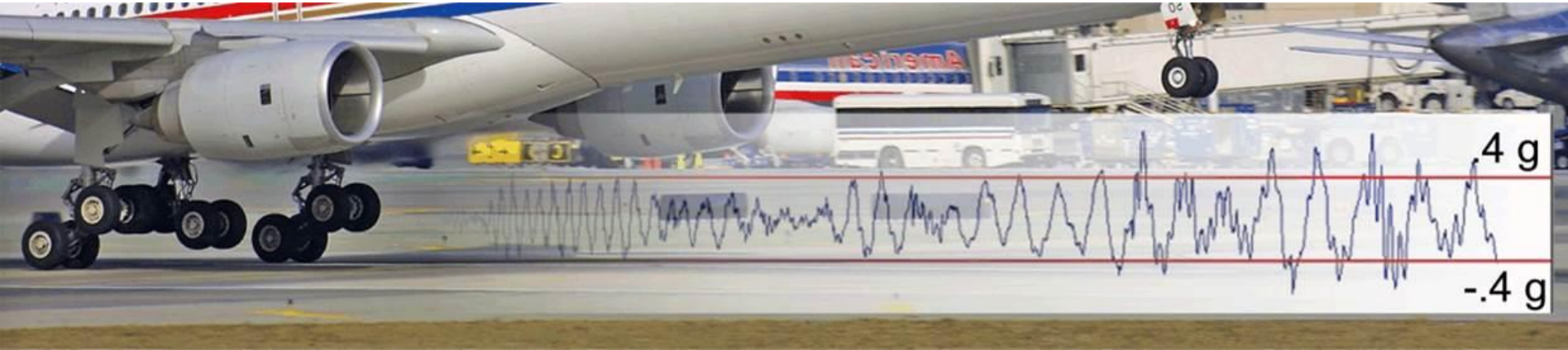
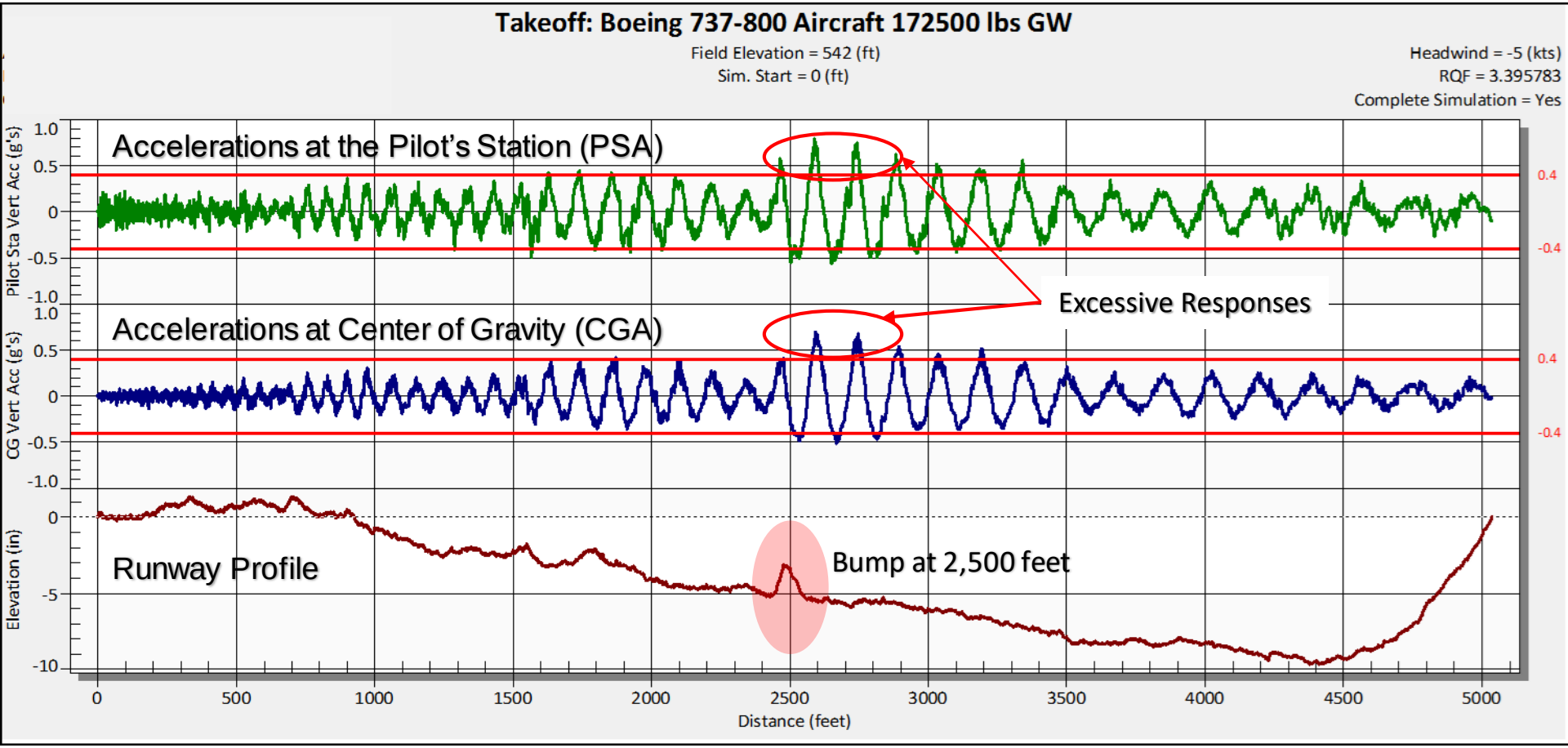
Why Aircraft Simulation

- Developed Aircraft Simulation Model
- 24 Commercial and Military Aircraft in Database
  - Taxi
  - Takeoff
  - Landing
  - Aborted Takeoff
- Computes Aircraft and Pavement Dynamic Loads Using the Measured Runway Profile Data

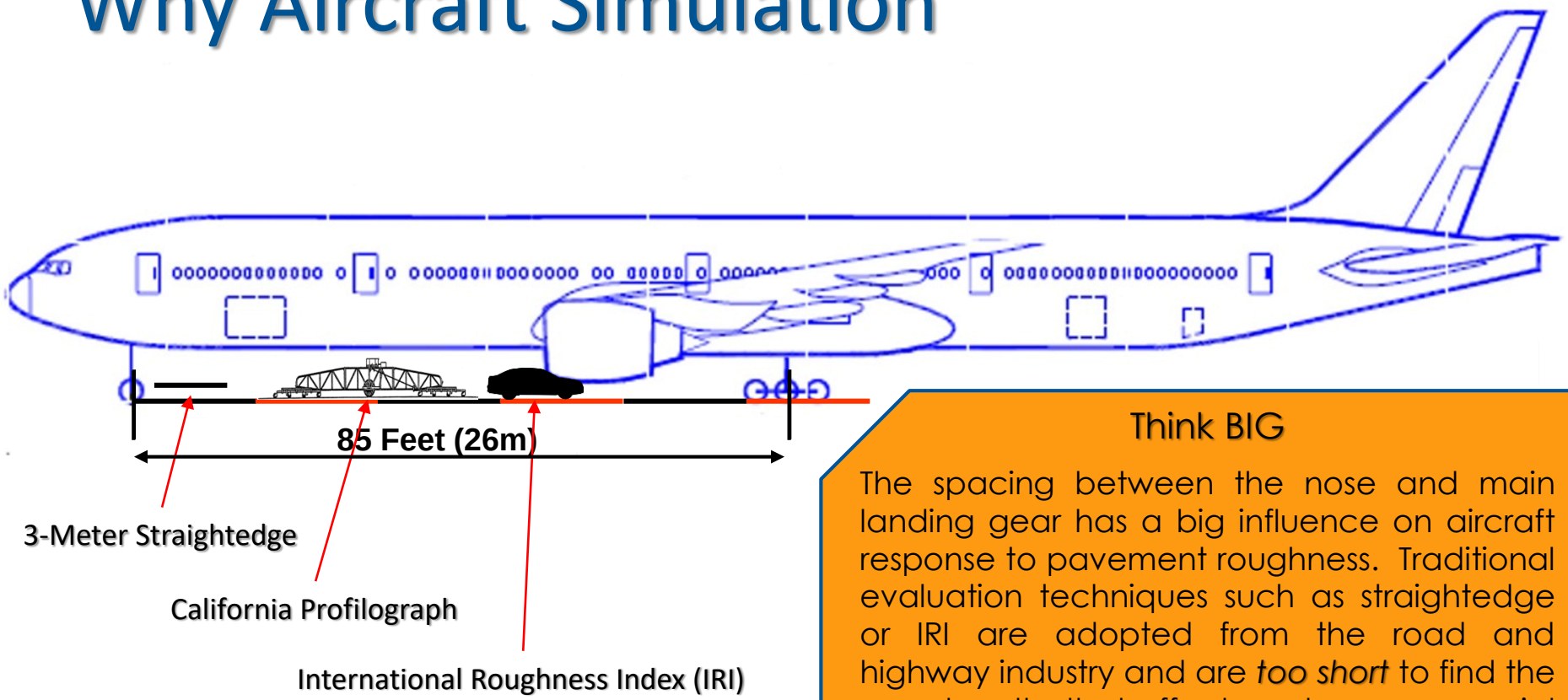




Aircraft Simulation Results

APR's simulation output shows the predicted response at the Pilot's Station (top portion of plot) and the Aircraft's Center of Gravity (center portion of plot) all in relation to the measured pavement profile (bottom portion of the plot). APR can simulate multiple commercial aircraft types. This example is the Boeing 737-800. APR uses .40G of accelerations (red lines) as the threshold of acceptability. Many studies by Boeing and research institutions show that .40G is when fatigue damage begins to occur and when pilots and passengers begin to complain due to excessive aircraft response.

Why Aircraft Simulation



Think BIG

The spacing between the nose and main landing gear has a big influence on aircraft response to pavement roughness. Traditional evaluation techniques such as straightedge or IRI are adopted from the road and highway industry and are *too short* to find the wavelengths that affect modern commercial aircraft. Commercial aircraft, such as this Boeing 777-200, can produce unwanted responses to events as long as 300 feet (100m). Aircraft simulation *fixes* this.

Simulation is Better than Boeing Bump (BBI)

- One Key Variable to an Aircraft's Response to Roughness is:

Aircraft SPEED

- The BBI *Does Not* Account for Aircraft Speed
- With BBI a Bump at the Beginning of a Runway will be Rated *the Same* as a Bump at 2,000 Feet (600m)

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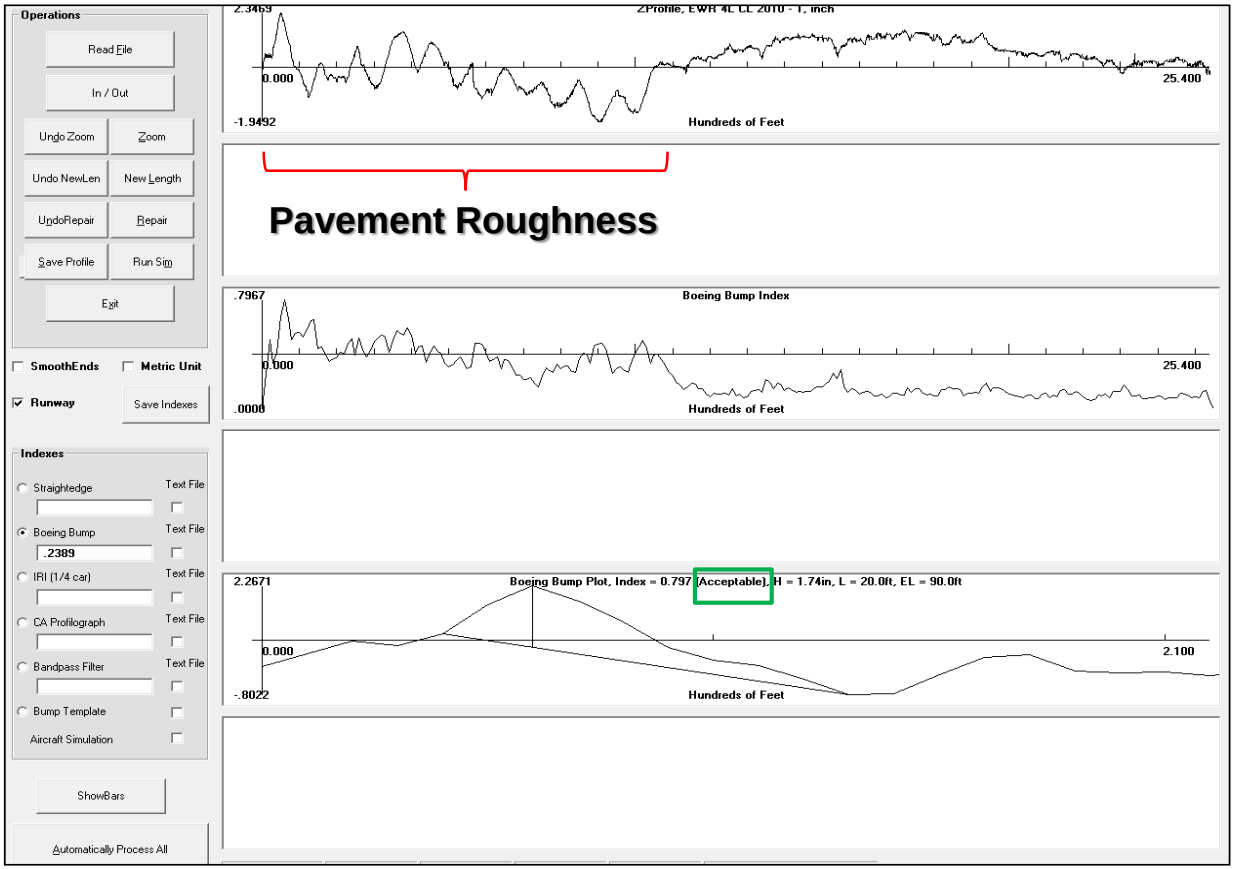
Case In Point



- Roughness in the First 1,000 Feet (300m)
- BBI as used in ProFAA Found this Roughness to be Acceptable.

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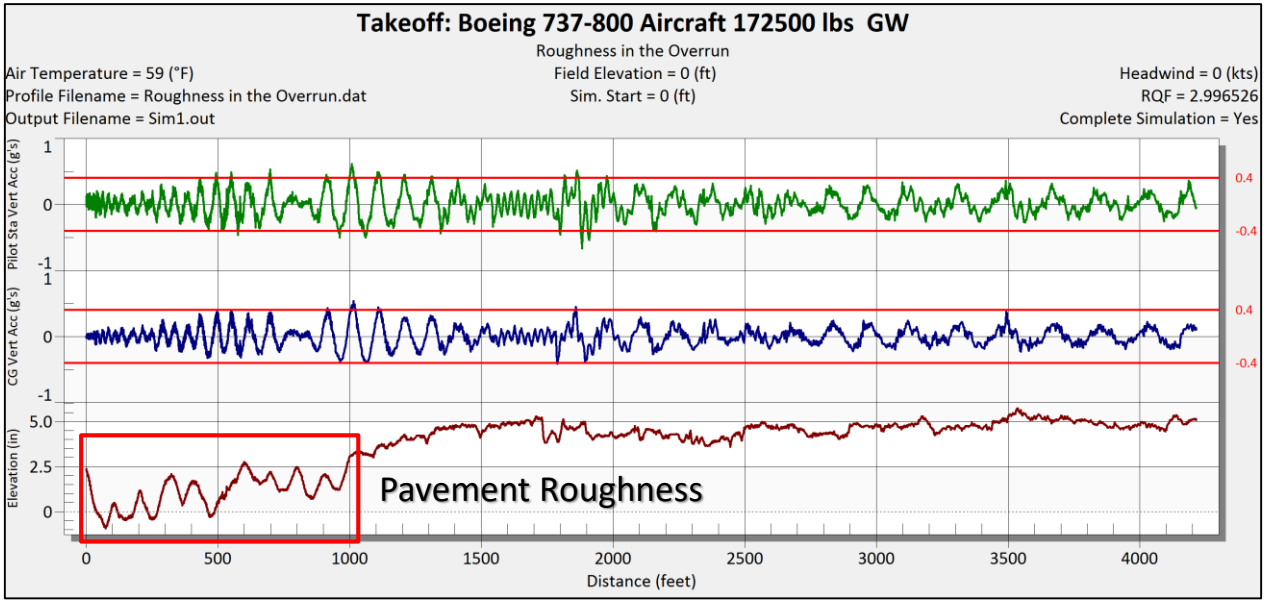
Case In Point



- Aircraft Simulation Would **Agree** with BBI in this Case
- The Aircraft does Respond, but mildly.
- What if the Roughness Were Further Down the Runway?

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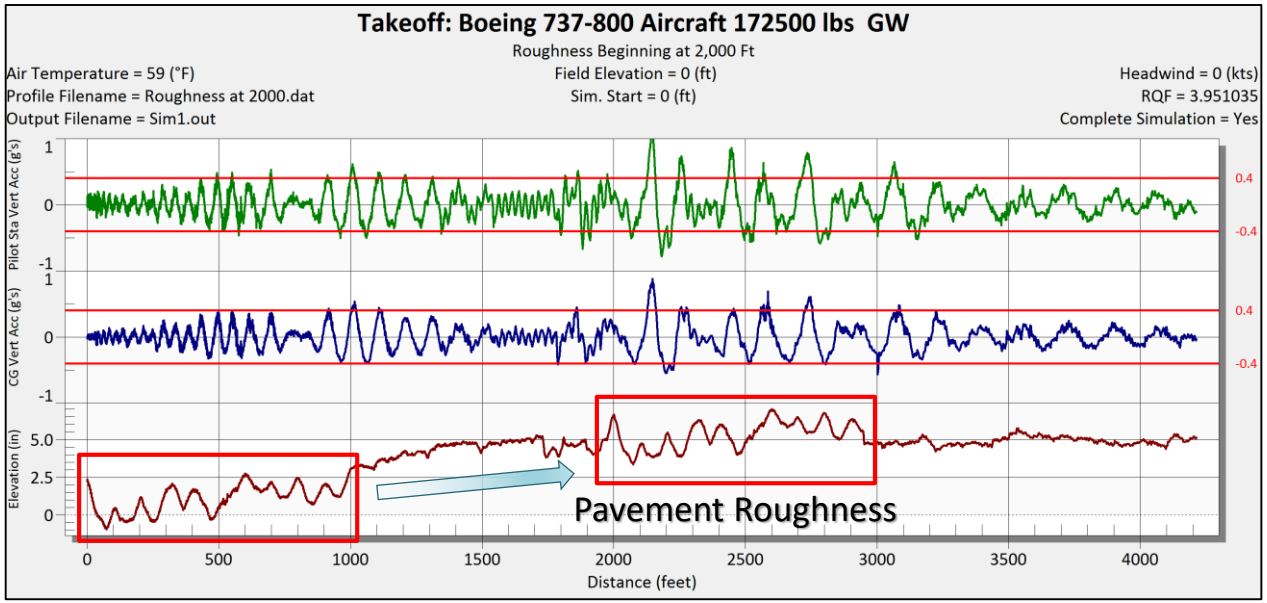
Same Rough Pavement, Now at 2,000 Feet (600m)



- If **Same Roughness** were at 2,000 Feet (600m)
  - Aircraft Response would be **Significant**
  - **Over 1G** of Acceleration at the Pilot's Station
  - **.88G** at the Aircraft's CG.
  - This is Considered **Very Rough.**

BBI Would Still Be Acceptable

- Commercial and Military Airport Services
  - Pavement Design Evaluation
  - New Pavement Acceptance
  - Dispute Resolution
  - Prioritize Pavement Maintenance
  - Pilot Reported Roughness
  - Optimize Repairs
  - Establish a Baseline Profile for Tracking

APR Consultants Customer Base

Summary

Aircraft Simulation Technology is the Best Method to Evaluate Airfield Pavement for Roughness.

- ✓ It can Evaluate Both Long and Short Wavelength Events
- ✓ It can Evaluate Roughness at Any Speed
- ✓ It can Predict the Aircraft's Response for Roughness at Any Location on the Runway
- ✓ The only Required Component is Accurate Profile Data of the Runway