

Runway Grooving and Skid Resistance

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Problem: The Water Covered Runway

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Problem: The Water Covered Runway

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Runway Grooving

- Misconceptions Have Developed Relative to Its Purpose During Its More Than 40 Years of Application.

Runway Grooving

- Prudent to Stress Reasons for Which It Is Not Used

Runway Grooving

- Not Used to Provide Drainage of Water from the Pavement Surface

Drainage

- Provided by the Transverse Slope of the Pavement Surface
- Grooves Are Cut in the Runway Surface Transversely to the Pavement Centerline and Make a Secondary Contribution to Drainage.

Runway Grooving

- Not Used to Provide an Increase in the Friction Capability of the Pavement Surface

Friction

- Friction Capability of the Pavement Surface Provided by the Quality of the Microtexture - Macrottexture Combination

Friction Provides the Skid Resistance

Skid Resistance by Other Names

- Friction
- Friction Coefficient
- Braking Coefficient

Runway Grooving

- Provides Forced Water Escape from the Pavement Surface under Aircraft Tires Traveling at High Speed

Runway Grooving

- Does Not Eliminate Hydroplaning
- Reduces Hydroplaning to a Manageable Level
- A Higher Degree of Contact is Maintained Between Aircraft Tires and the Pavement Surface under the Condition of Standing Water.

Runway Grooving

- Enables Pavement Surface Microtexture - Macrotexture Combination to Provide Sufficient Braking and Directional Control to Aircraft
- Slight to Significant as Speed of Aircraft or Water Depth on Pavement is Reduced

Runway Grooving

- Reduces Dynamic Hydroplaning (Standing Water)
- Reduces Viscous Hydroplaning (Wet Pavement with Little to No Standing Water)

Functions of Runway Surface Characteristics in the Presence of Water

- Transverse Slope Provides Drainage.
- Texture of Pavement Provides Friction.
- Grooving Enables Aircraft Tires to Contact the Pavement.

Runway Grooving

- In the Presence of Water, Totally Worn Aircraft Tires Experience Better Braking on a Grooved Pavement than Newly Treaded Tires on a Nongrooved Pavement.

Porous Friction Course Substitutes for Runway Grooving

- Provides Drainage of Water from the Pavement Surface (Primary)
- Provides Forced Water Escape from the Pavement Surface under Aircraft Tires Traveling at High Speed Similar to Grooving (Secondary)
- Application Limited Relative to Density of Aircraft Operations

Not Substitutes for Runway Grooving

- Tire Tread
(Demonstrated in Full Scale Tests)
- Coarse Pavement Surface Macrotexture
(Demonstrated to a Limited Degree in Full Scale Tests)

Grooving vs. Macrotexture

- Grooving Lies Below the Pavement Surface. Flexibility of Tire Cannot Seal the Path of Water Escape.
- Macrotexture Is the Pavement Surface. Flexibility of Tire Can Seal the Path of Water Escape.

Grooving vs. Macrotexture



FAA Full Scale Test Program Braking/Hydroplaning

- 1975 to 1983
- 600 Full Scale Tests
- Dynamic Test Track
- Asphalt and Portland Cement Concrete
- Variety of Pavement Surface Treatments
- Wet to Flooded Conditions
- Speeds of 30 to 150 Knots

FAA Full Scale Test Program Braking/Hydroplaning

- Aircraft Tire, 49 by 17, 26 ply, type VII (Boeing 727 and 747)
- Tire Pressure, 140 psi
- Wheel Load, 35,000 lbs
- Maximum Braking Data Base
- Test Facility, NAEC (Navy), Lakehurst, New Jersey

FAA Full Scale Test Program

Braking/Hydroplaning

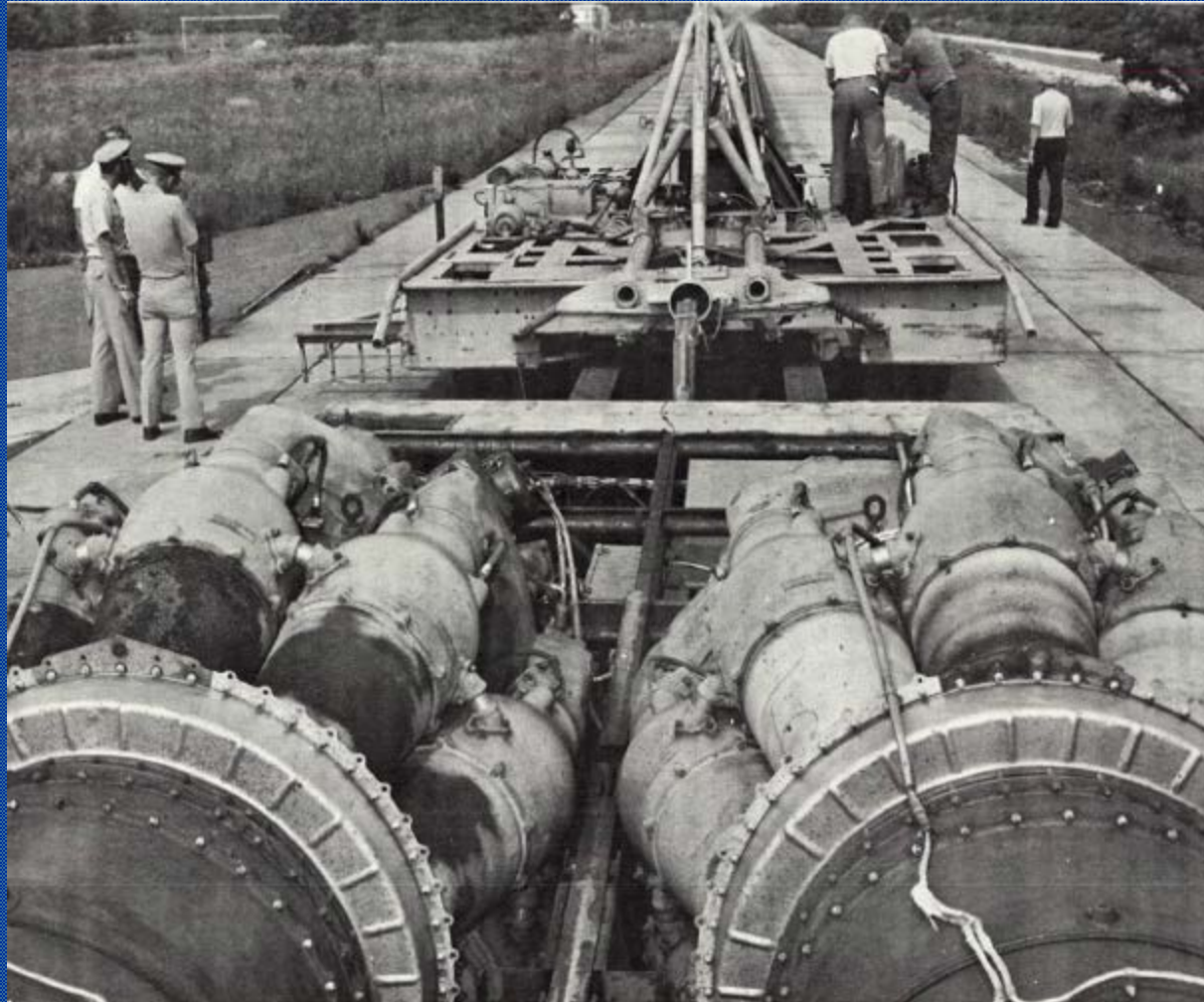
Water Depth Conditions on Pavement

- Wet 0.00 in. Standing Water
- Puddled 0.10 in. Standing Water
 2.54 mm
- Flooded 0.25 in. Standing Water
 6.35 mm

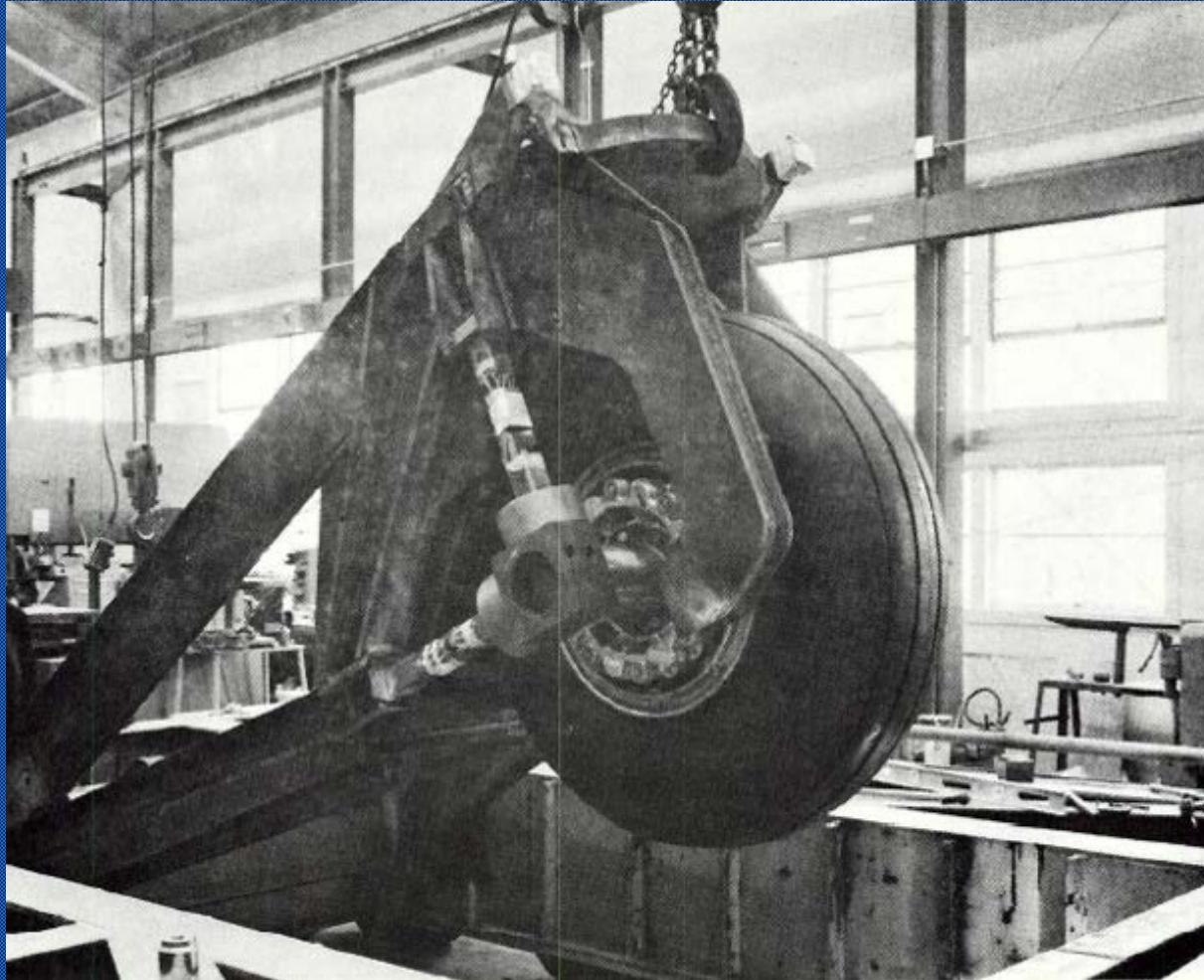
Launch End of Test Track



Launch End of Test Track



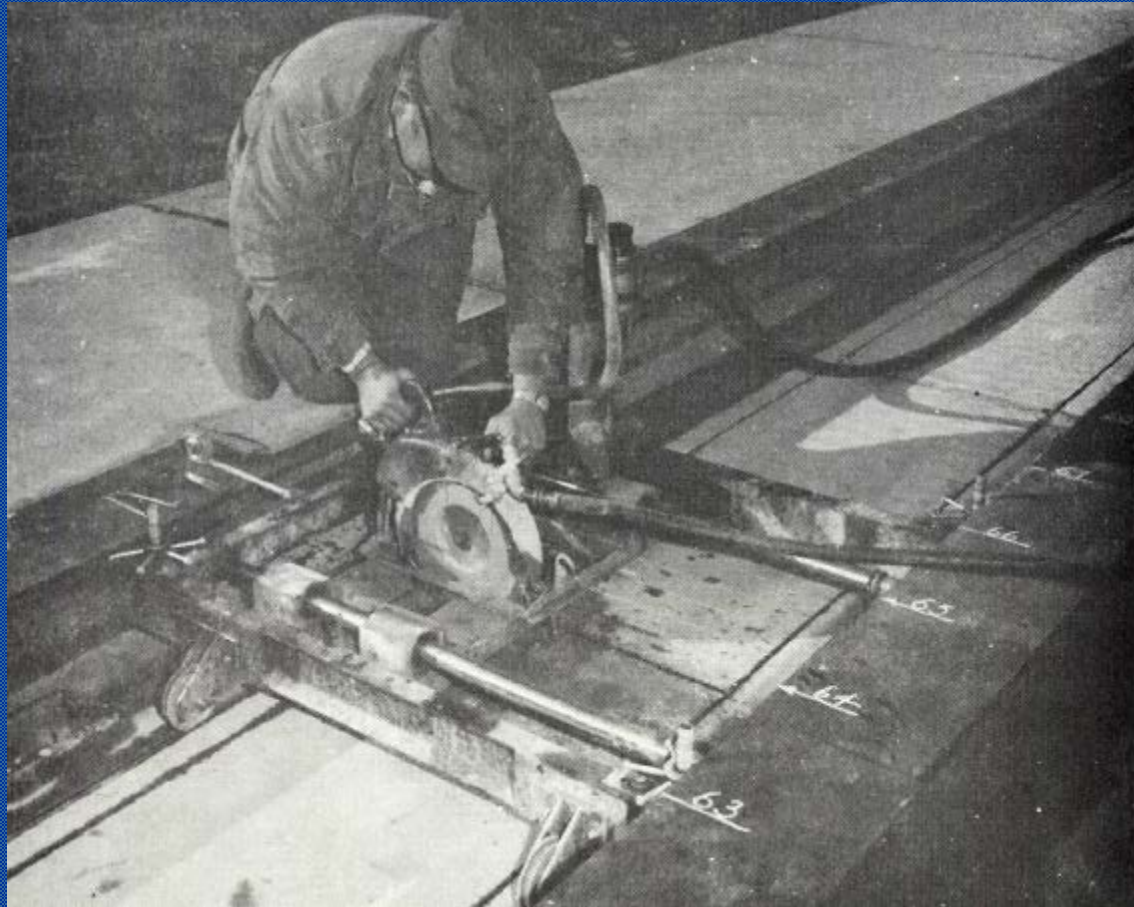
Dynamometer with Tire-Wheel Assembly



New and Worn Tire Tread



Saw Cutting Grooves in the Test Pavement



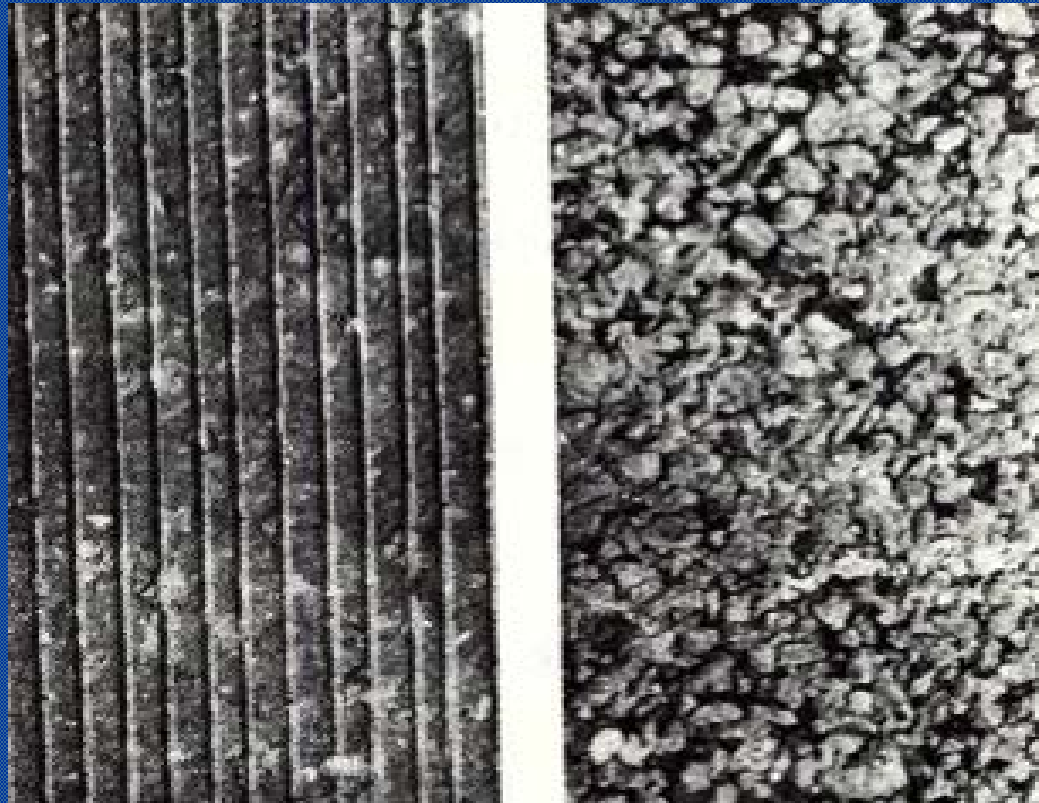
Test Pavement at the Recovery End of the Test Track



1/4 x 1/4 in. Grooves Spaced at
1 1/4 , 2, and 3 ins.



1/8 x 1/8 in. Grooves Spaced at 1/2 in. and Porous Friction Course



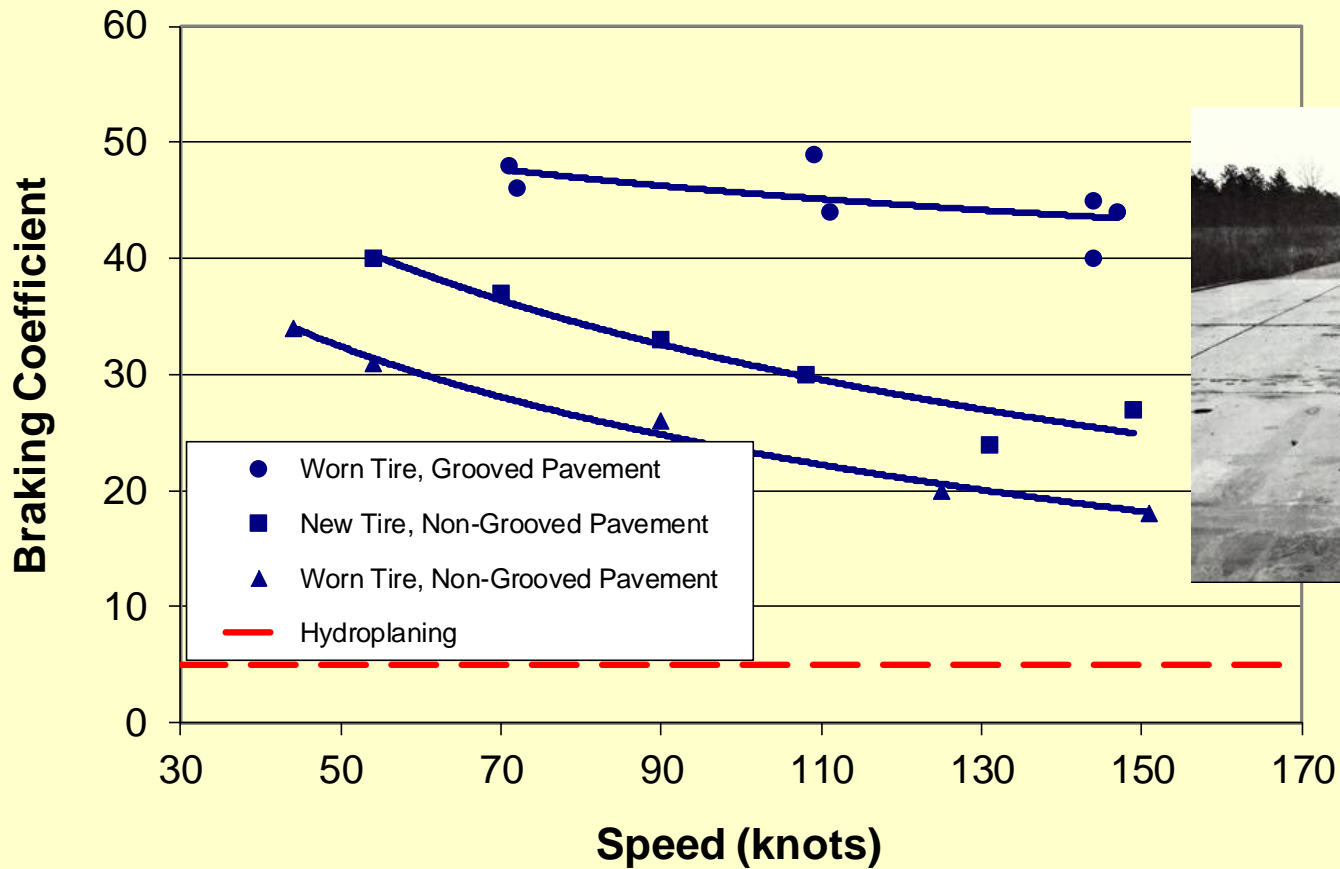
Experimental Percussive Grooves at 3 in. Spacing



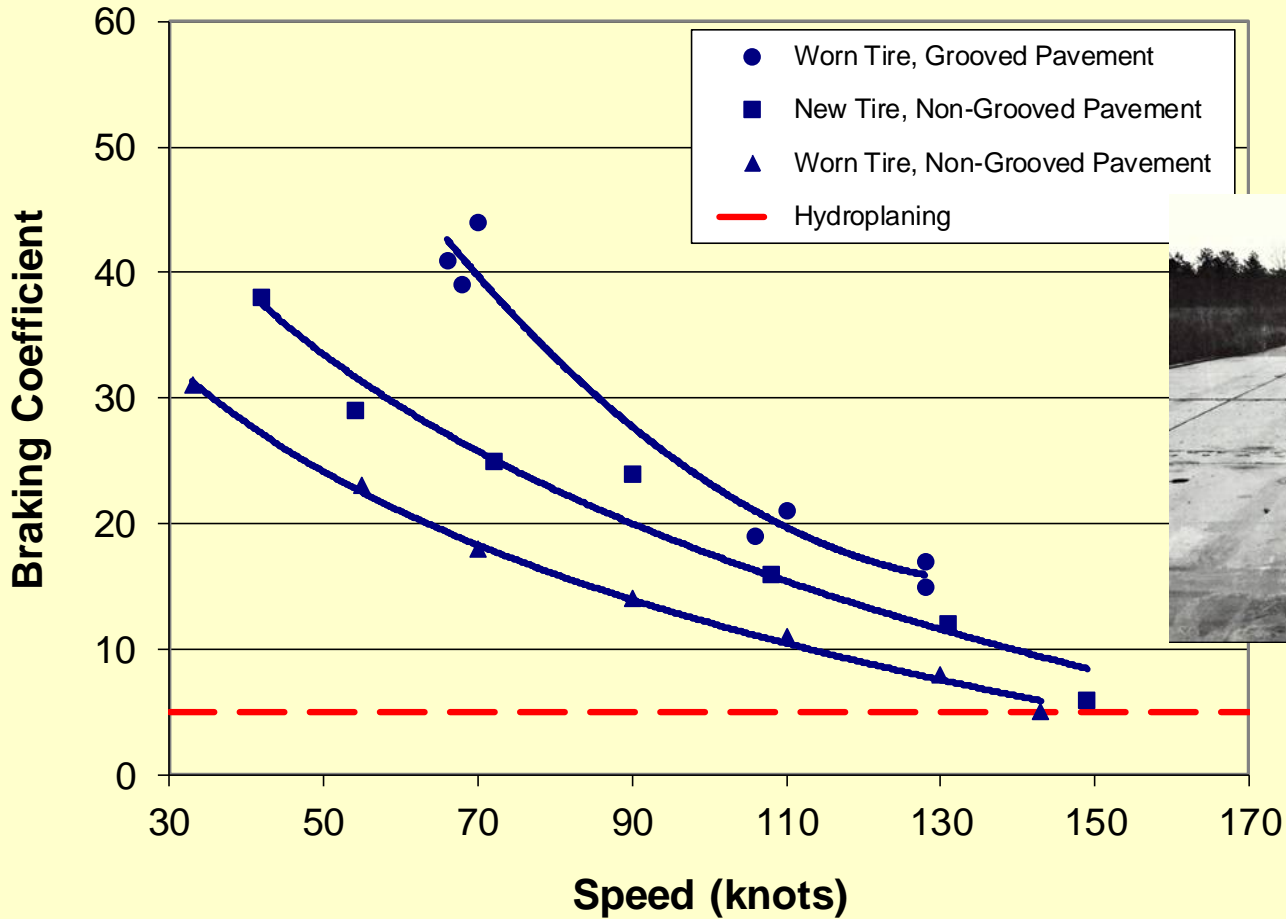
Grooved Pavement

- FAA Standard 1/4 x 1/4 Saw-Cut Grooves Spaced at 1½ inches
- Represented by Curve Fits between Data Points for 1¼ inch and 2 inch Spacing
- FAA Standard in Metric 6mm x6mm Grooves Spaced at 38 mm

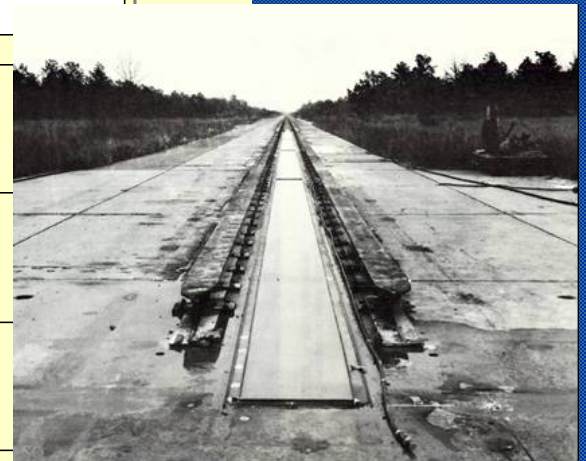
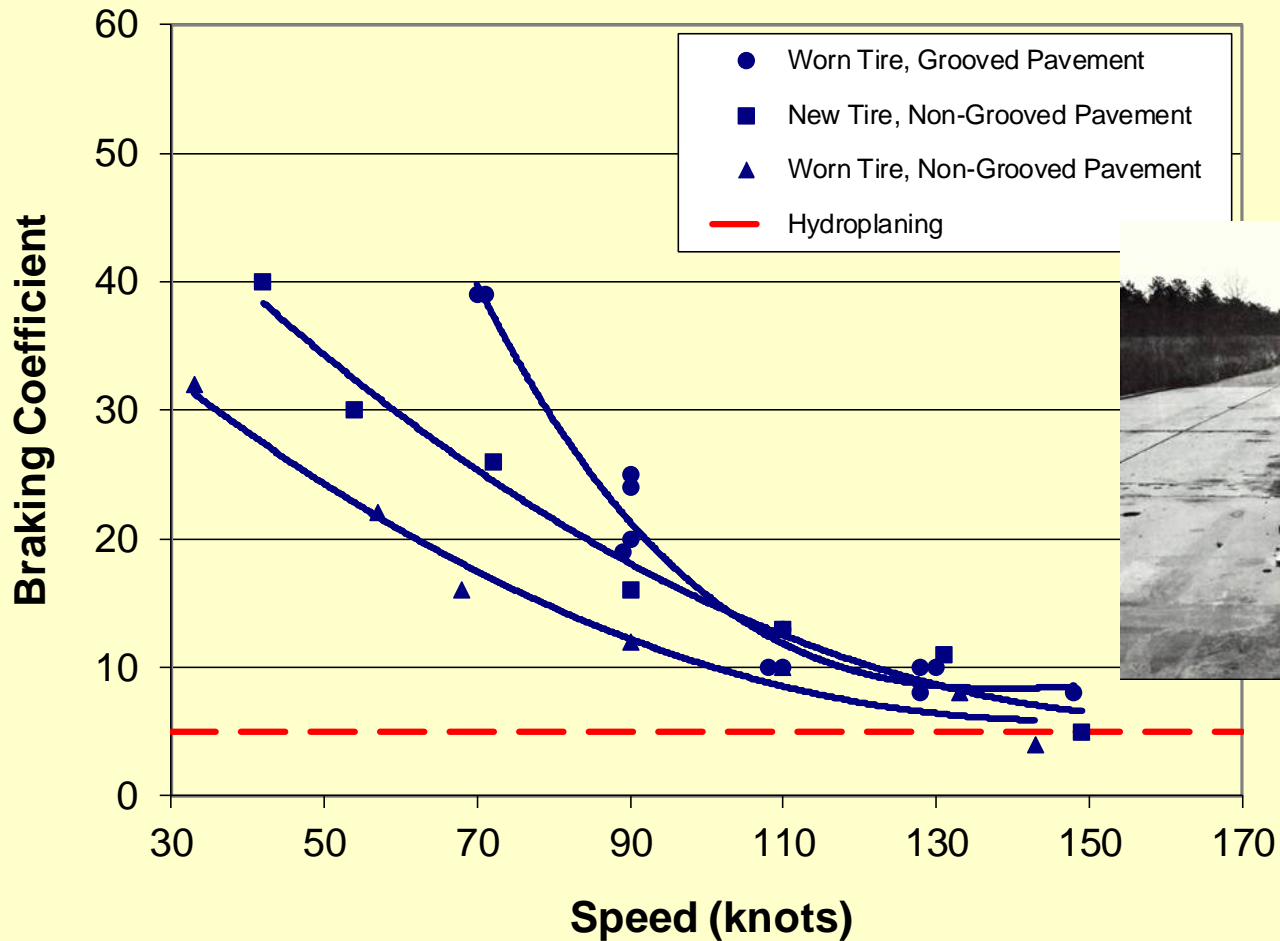
Braking on a Wet Asphalt Pavement



Braking on a Puddled Asphalt Pavement



Braking on Flooded Asphalt Pavement



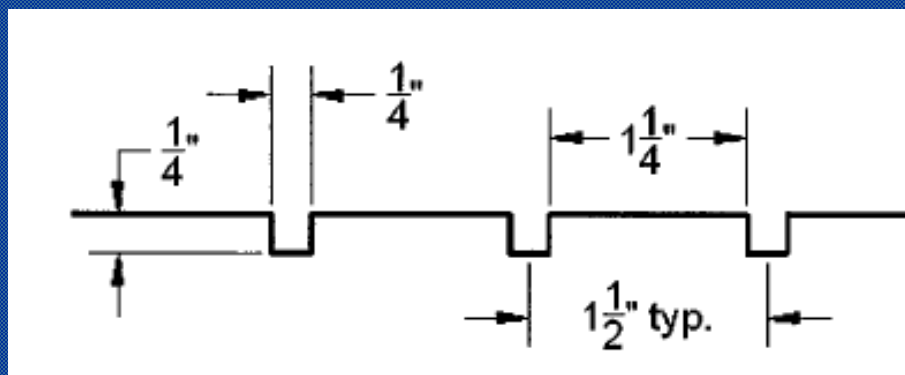
Essentials of an Aircraft Braking/Hydroplaning Test System

- Full Scale
- High Speed
- Standing Water
- Uniformity of Water Depths
- Close Control of Variables

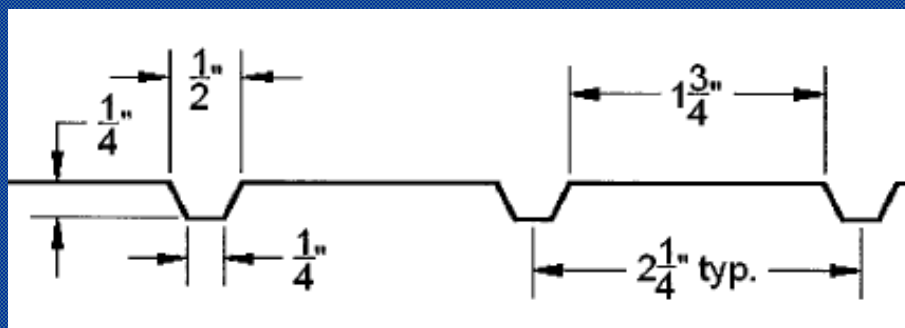
Aircraft Braking/Hydroplaning Test System Scenarios

- Full Scale Tire-Wheel Assembly on a Dynamic Test Track (Best Control of Variables)
- Aircraft on a Runway

FAA Standard and Proposed Saw-Cut Groove Patterns

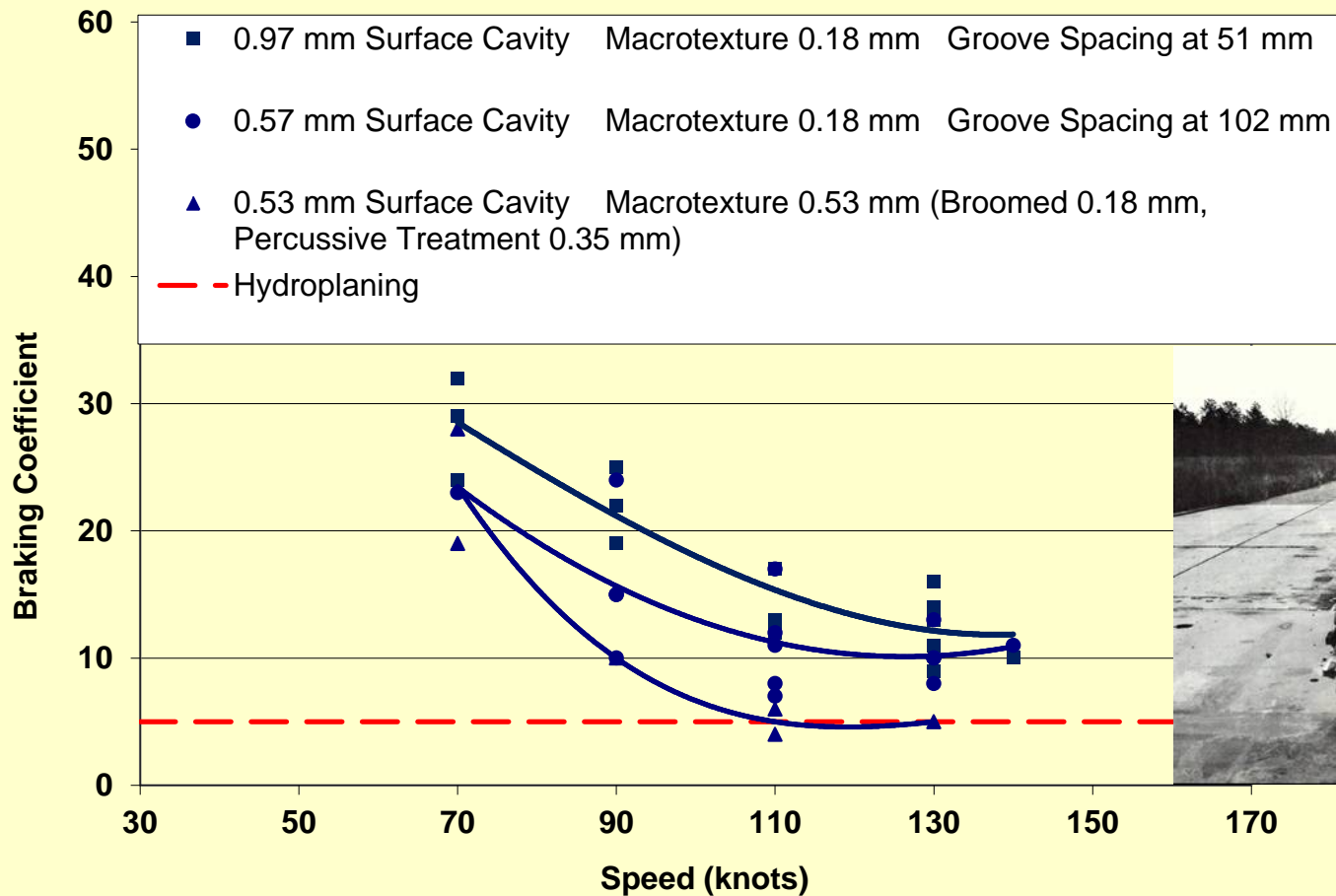


Standard



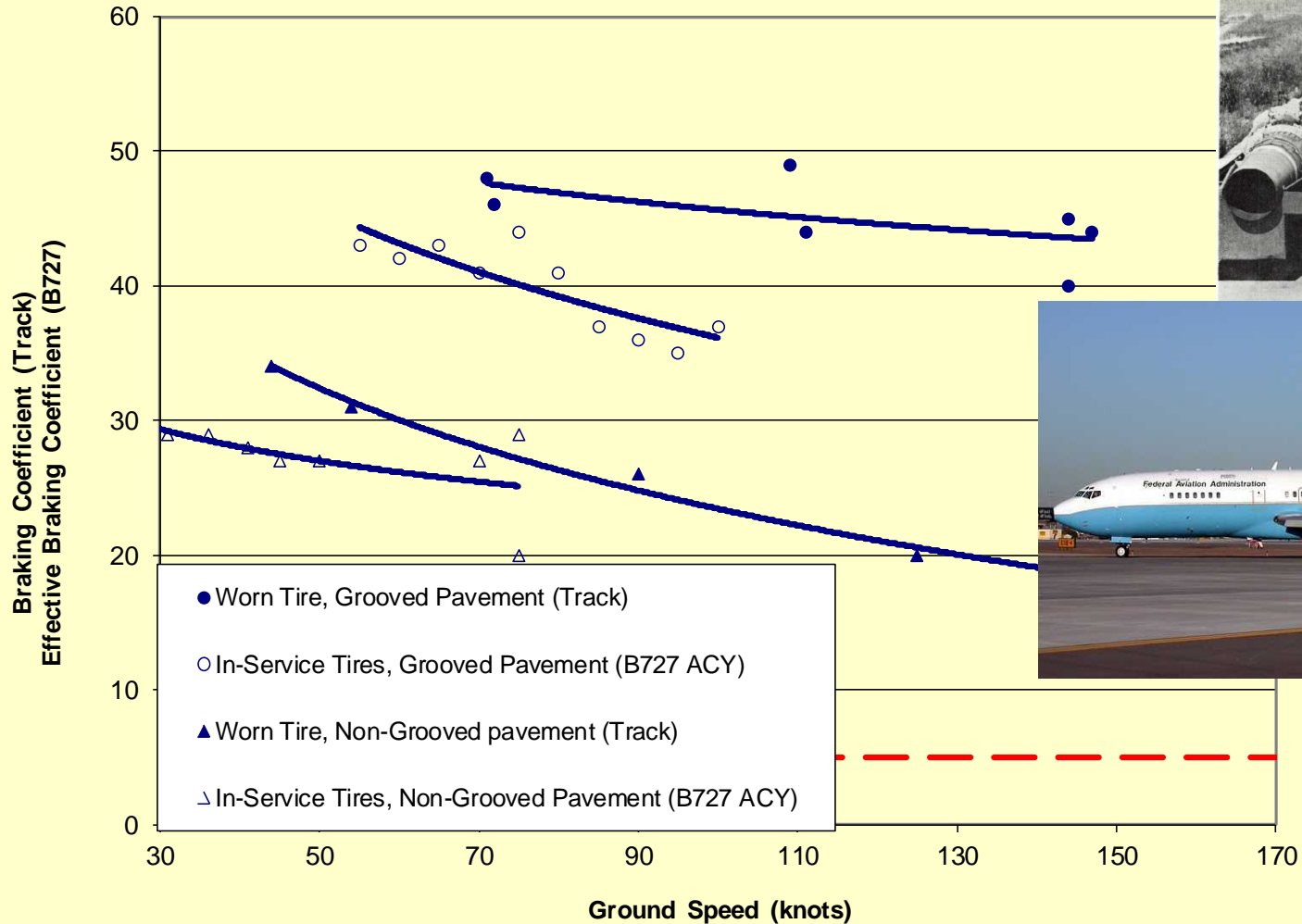
Proposed

Grooving vs. Macrotexture - New Tire on a Puddled PCC Pavement

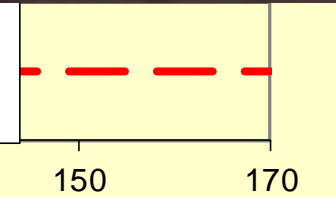
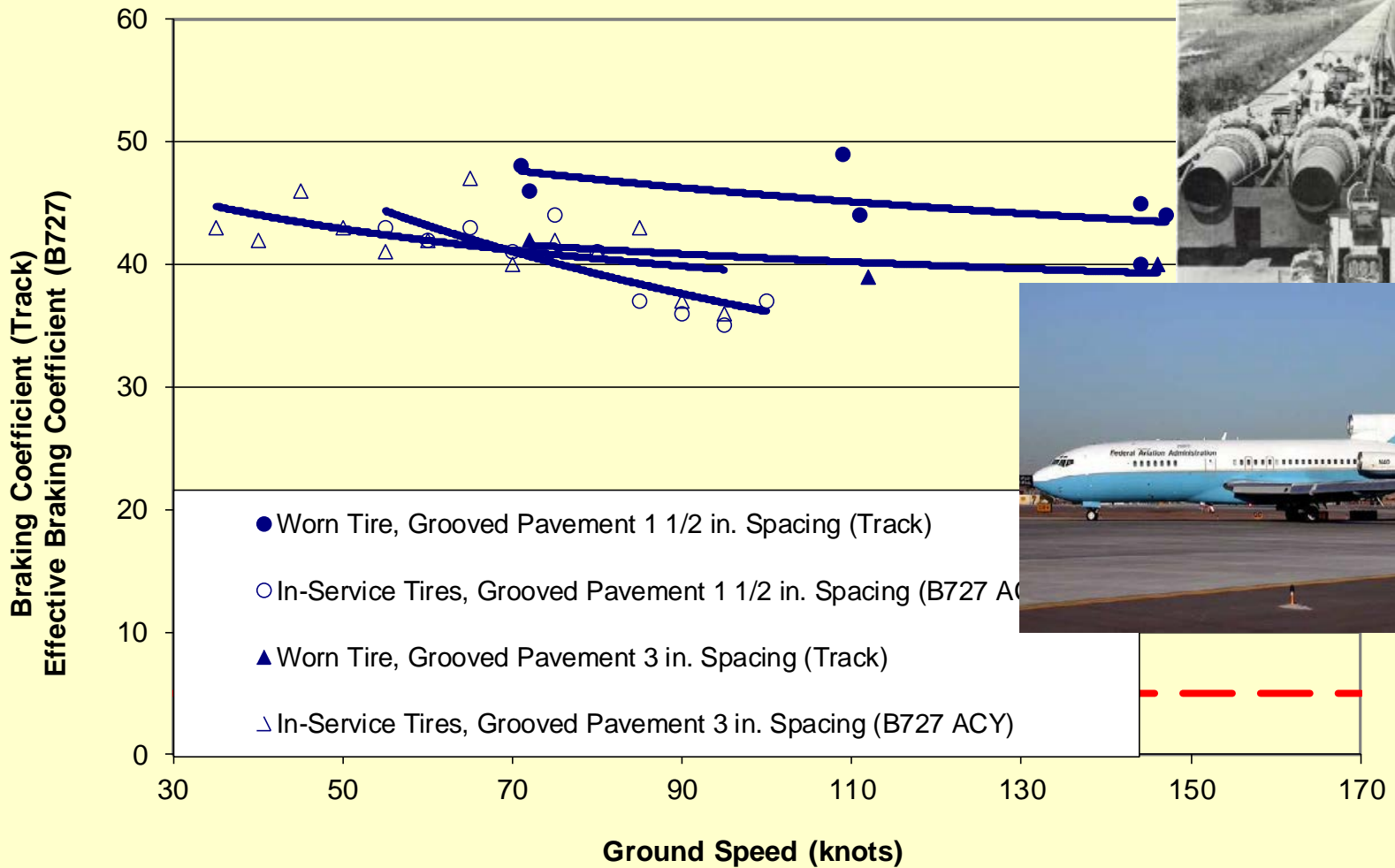


Relationship between Results on the Test Track and Performance of the Aircraft on a Runway

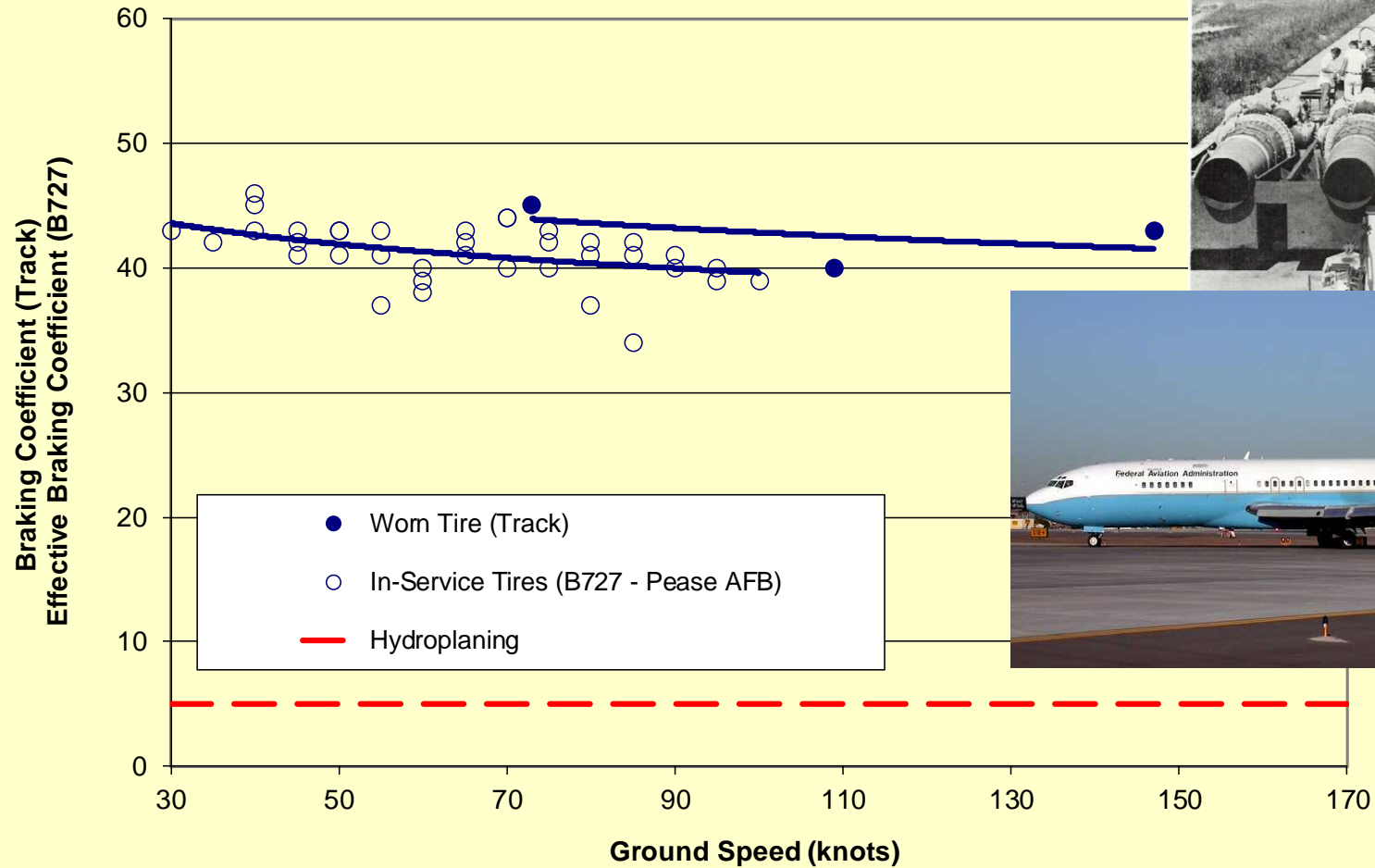
Braking on a Wet Asphalt Pavement



Braking on a Wet Asphalt Pavement



Braking on Wet Porous Friction Course



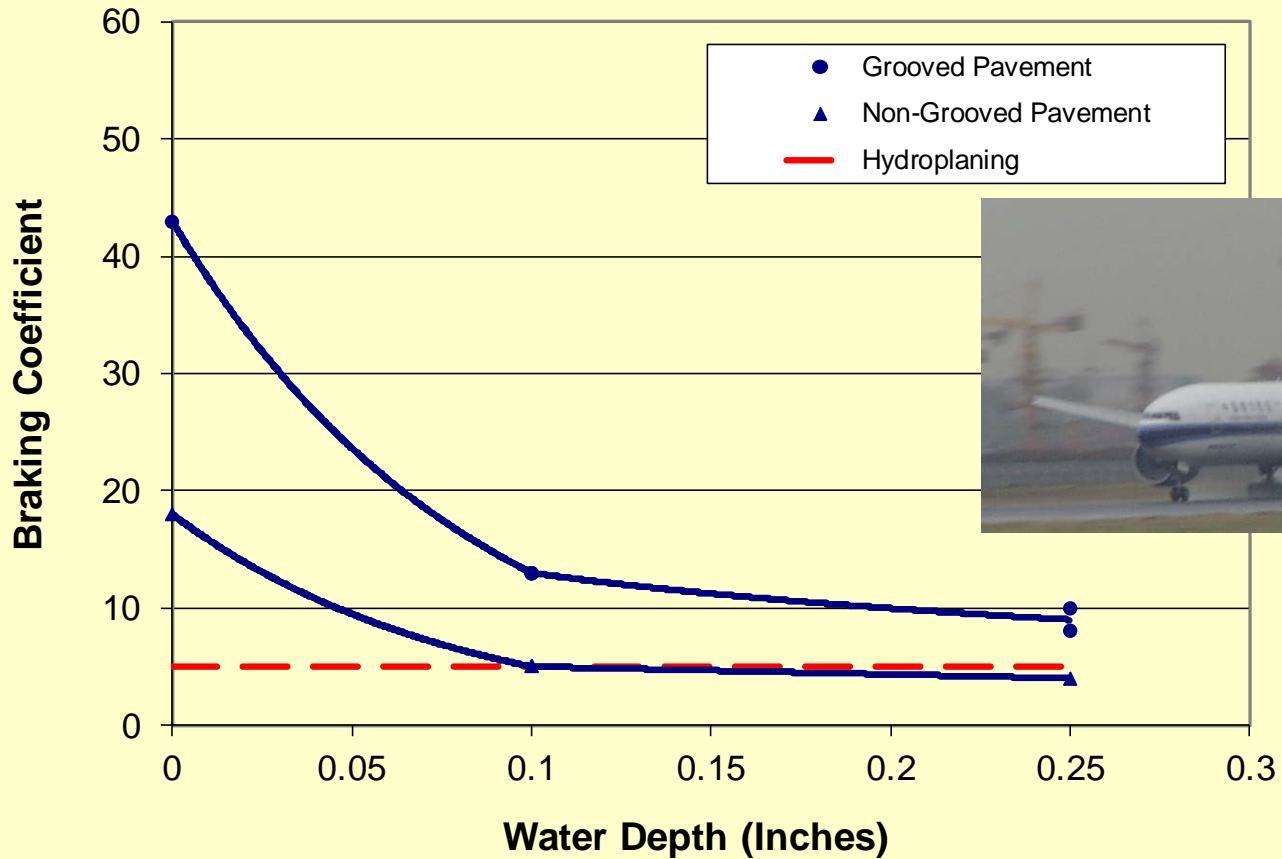
Dynamic Test Track Data Can Be
Used to Simulate Tire-Pavement
Interaction During the Landing and
Takeoff of a Jet Transport Aircraft
with Worn Tires on a Runway
under Rainfall Conditions.

Inference Drawn from Simulation on Asphalt Pavement

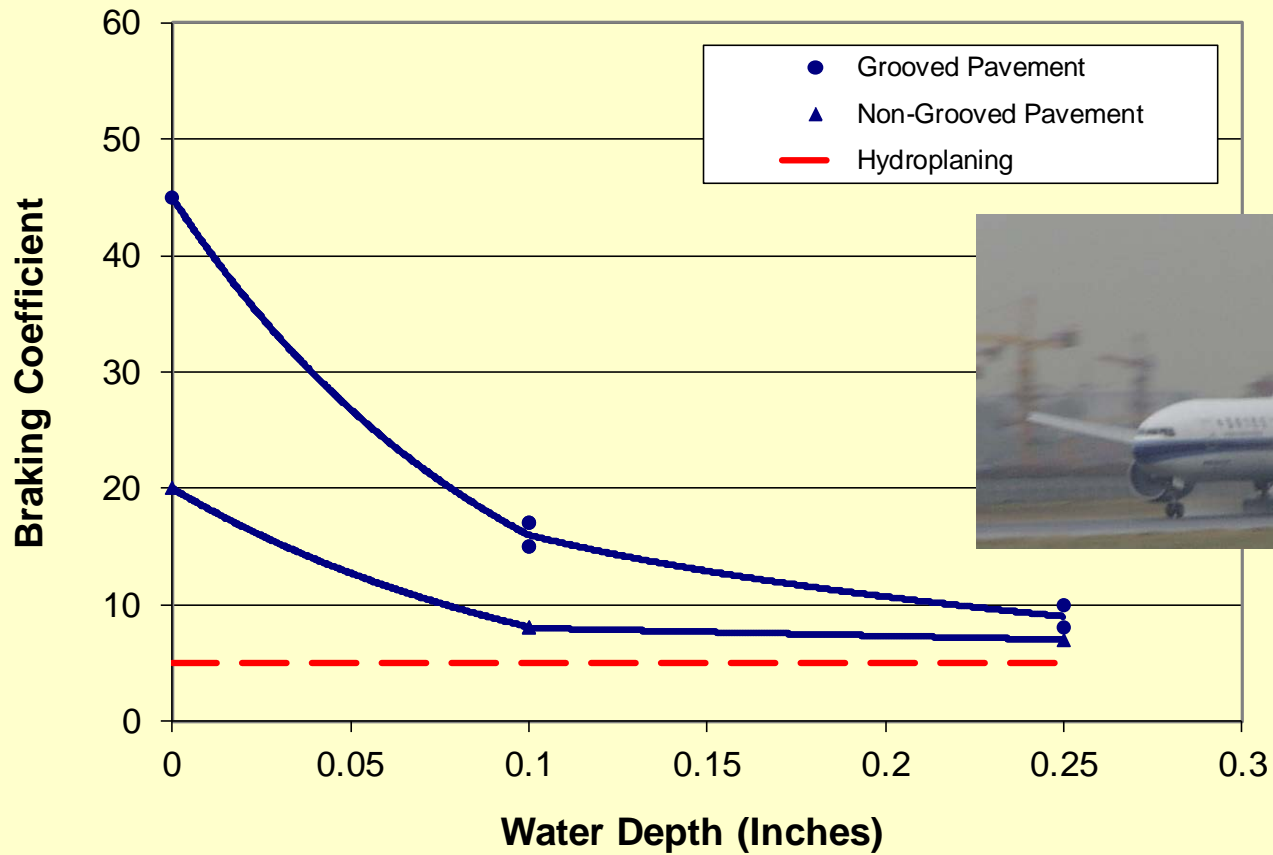
- Runway Grooving Offers the Potential to Double The Magnitude of Tire-Pavement Interaction for Jet Transport Aircraft Operating on Water Covered Runways.

Landing

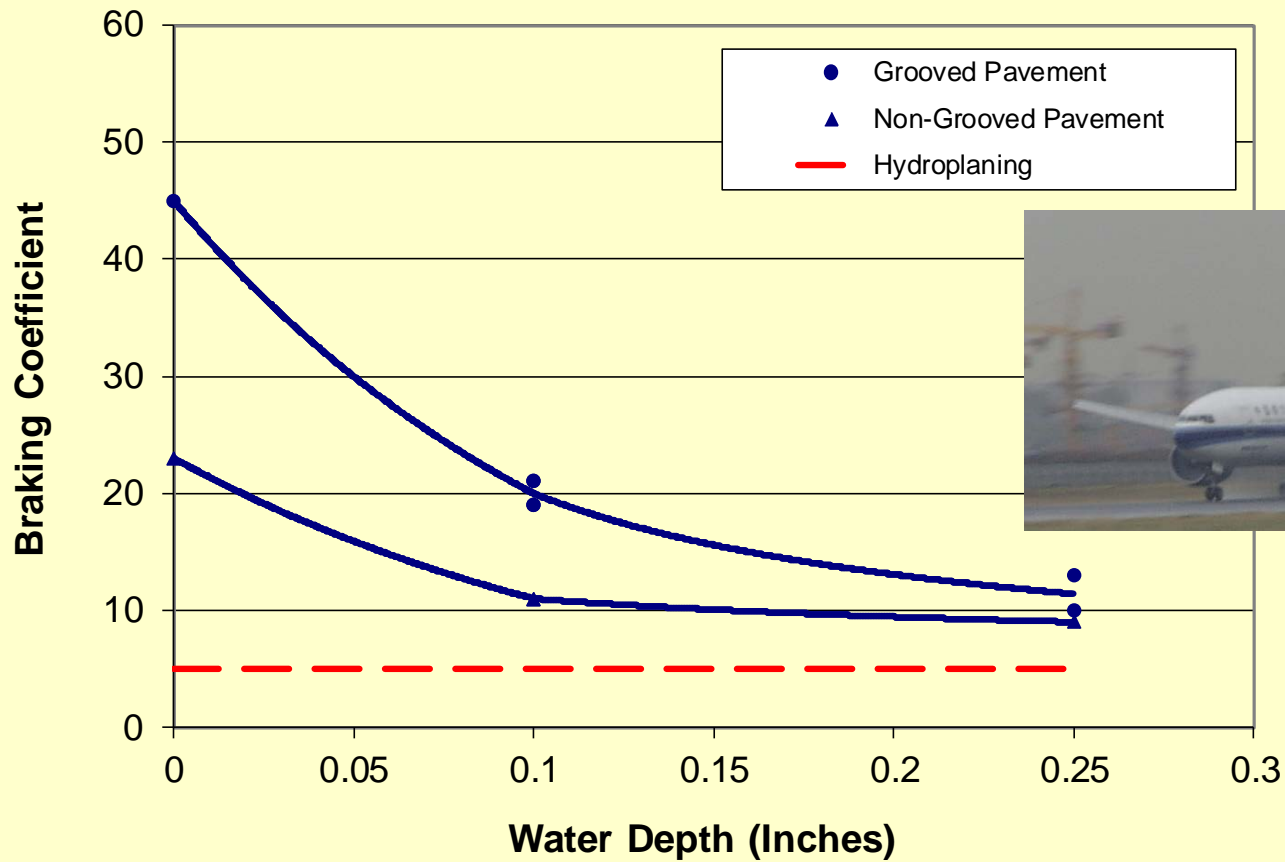
Fast Touchdown at 150 Knots



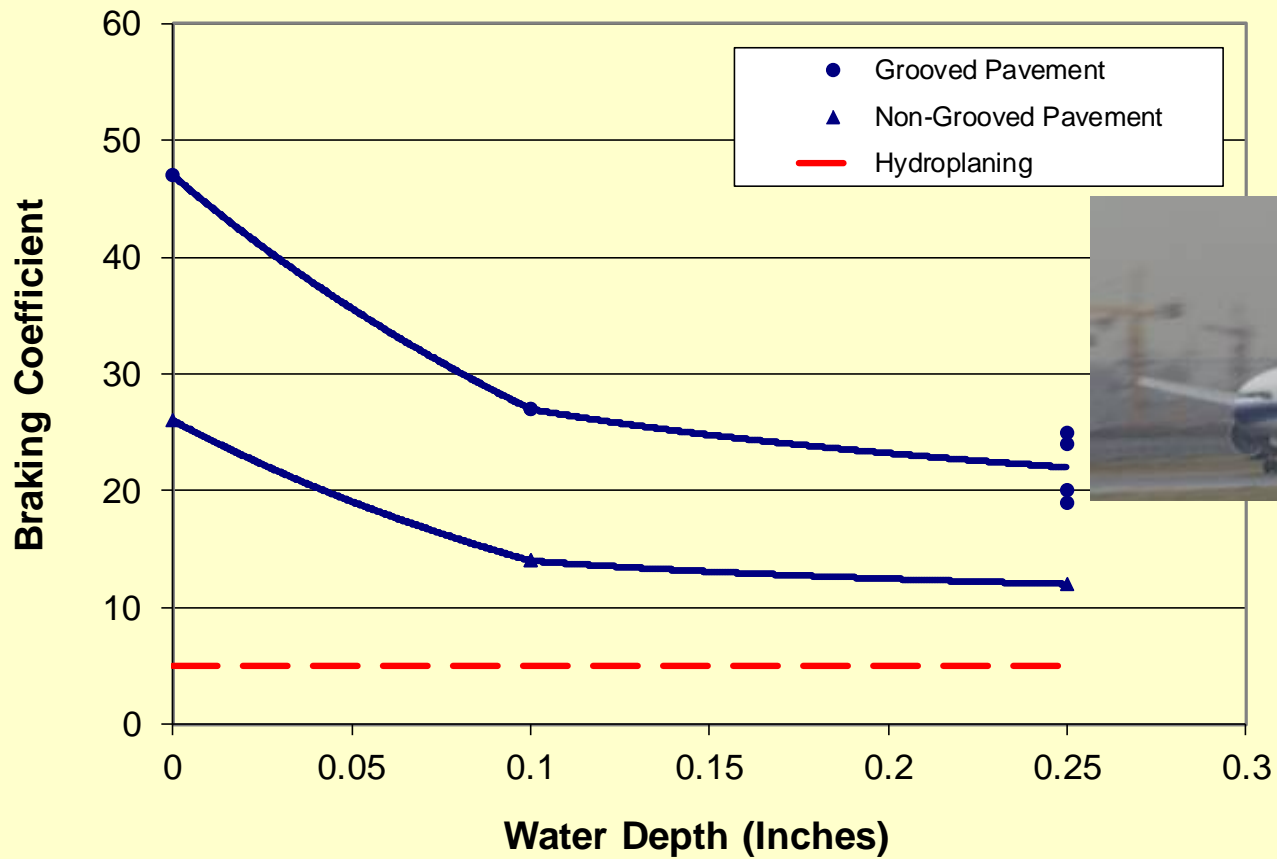
Touchdown at 130 Knots



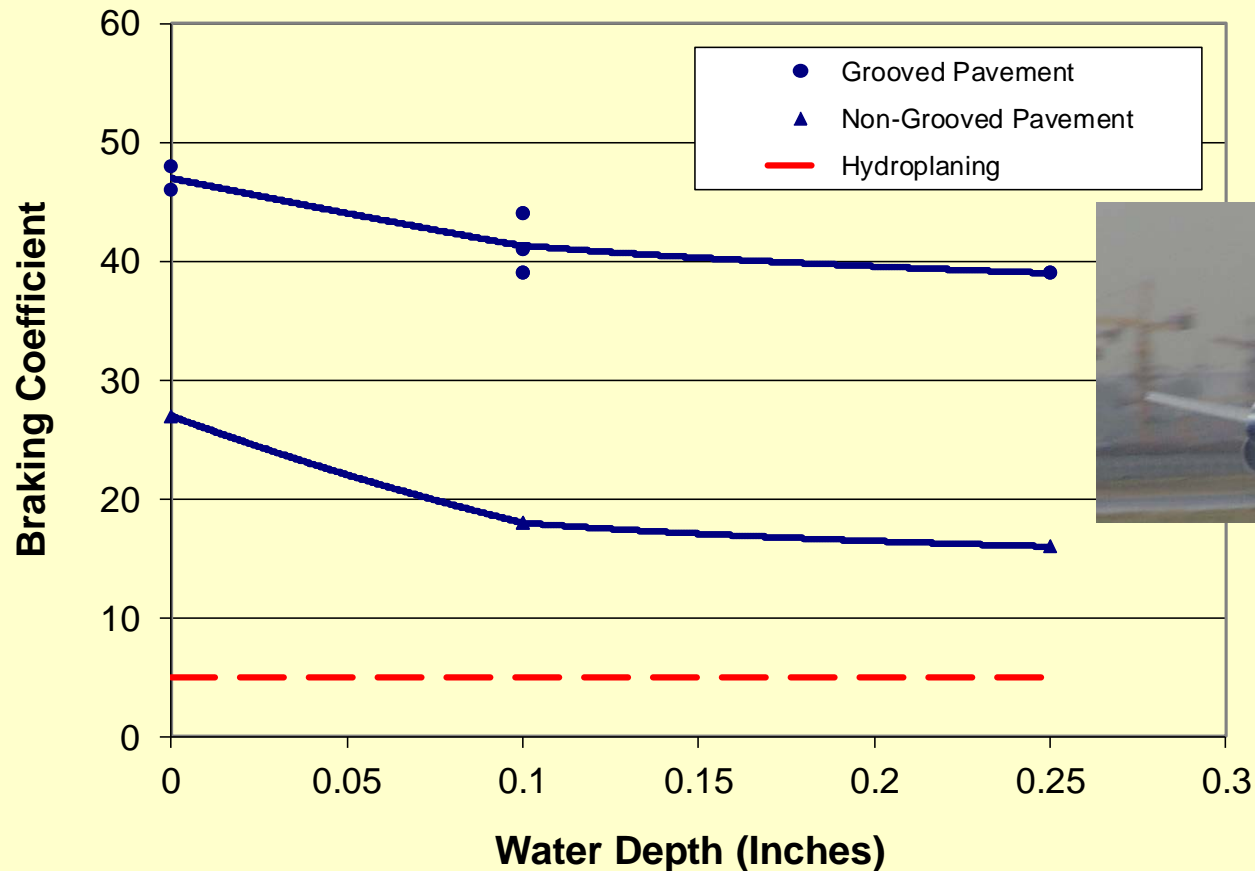
Braking at 110 Knots



Braking at 90 Knots

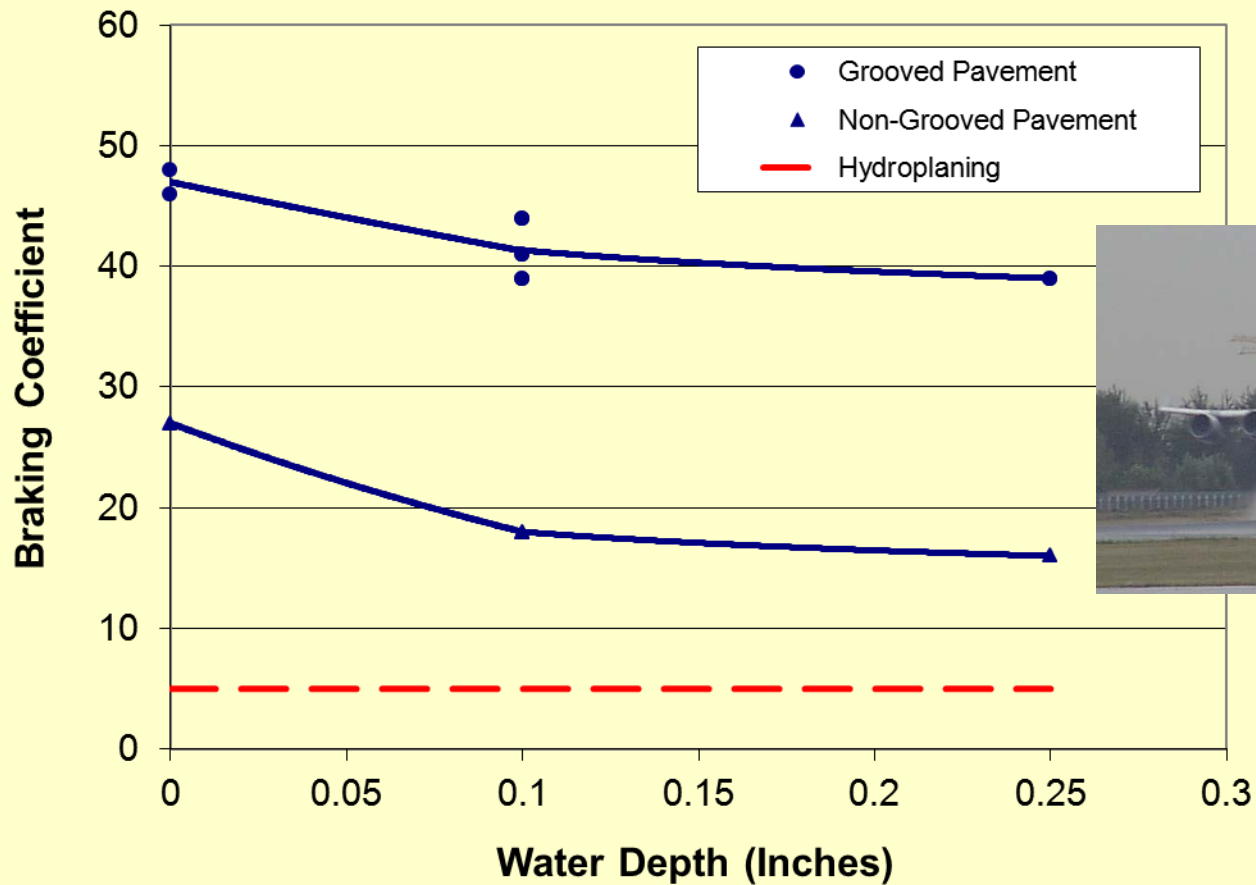


Braking at 70 Knots, Approaching High Speed Turnoff

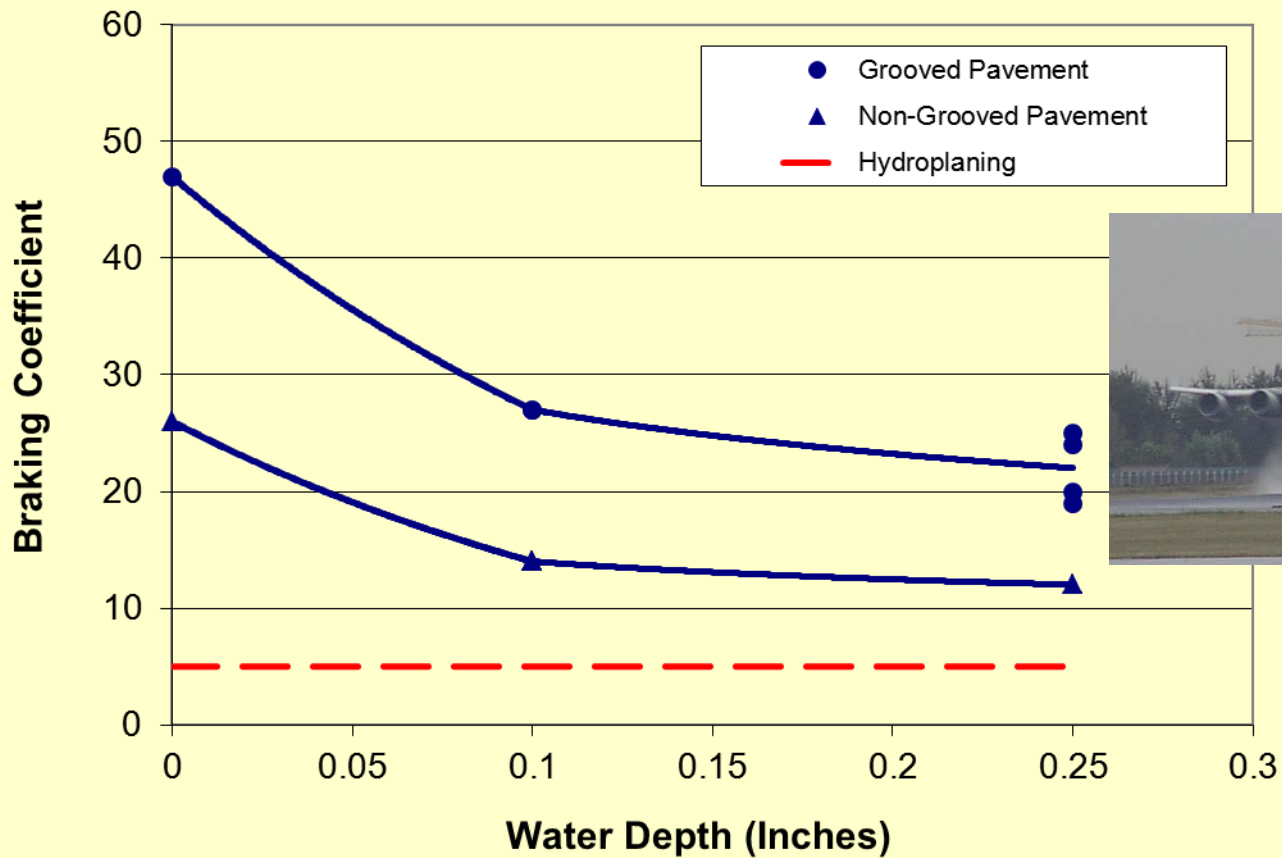


Takeoff

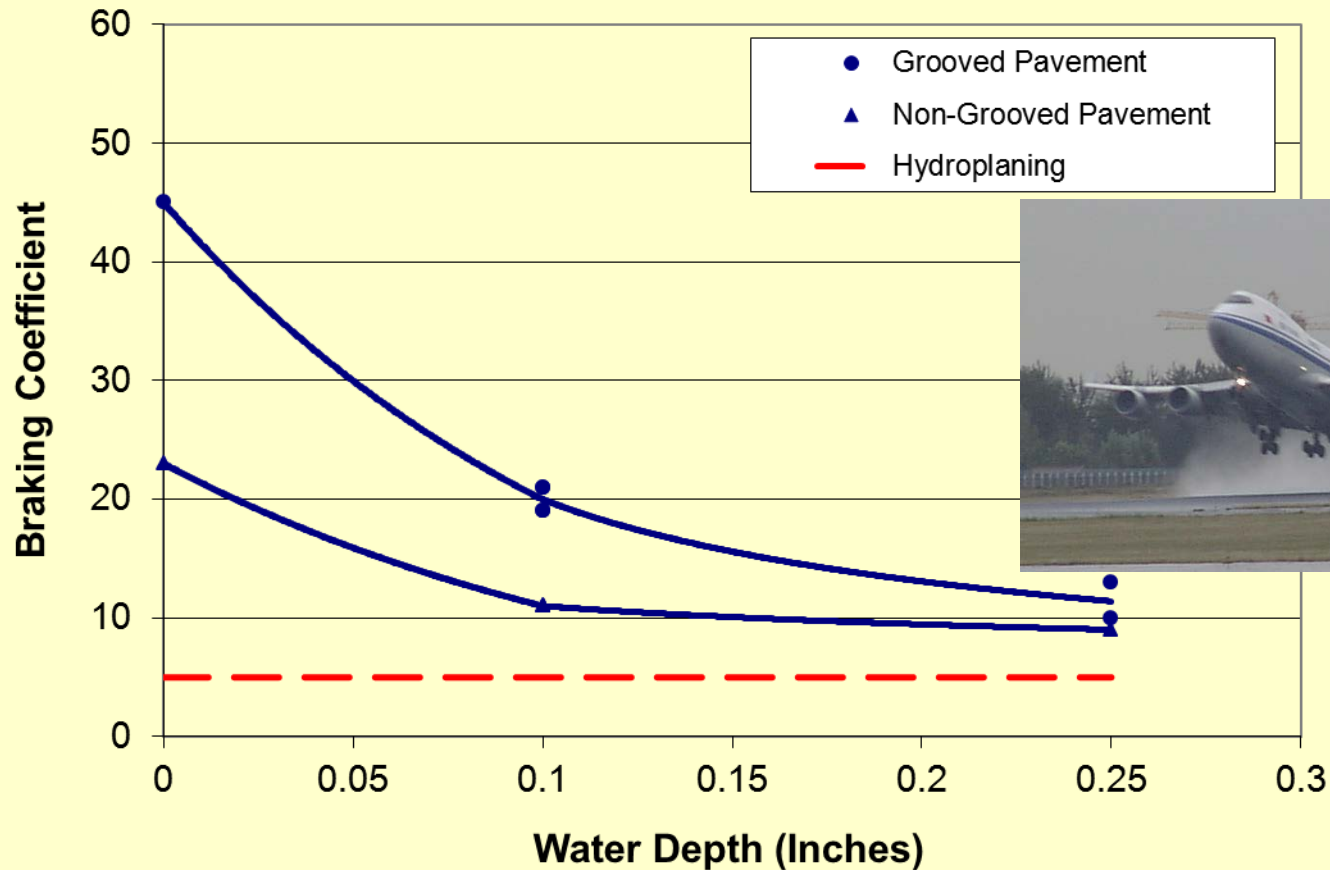
Takeoff Roll at 70 Knots



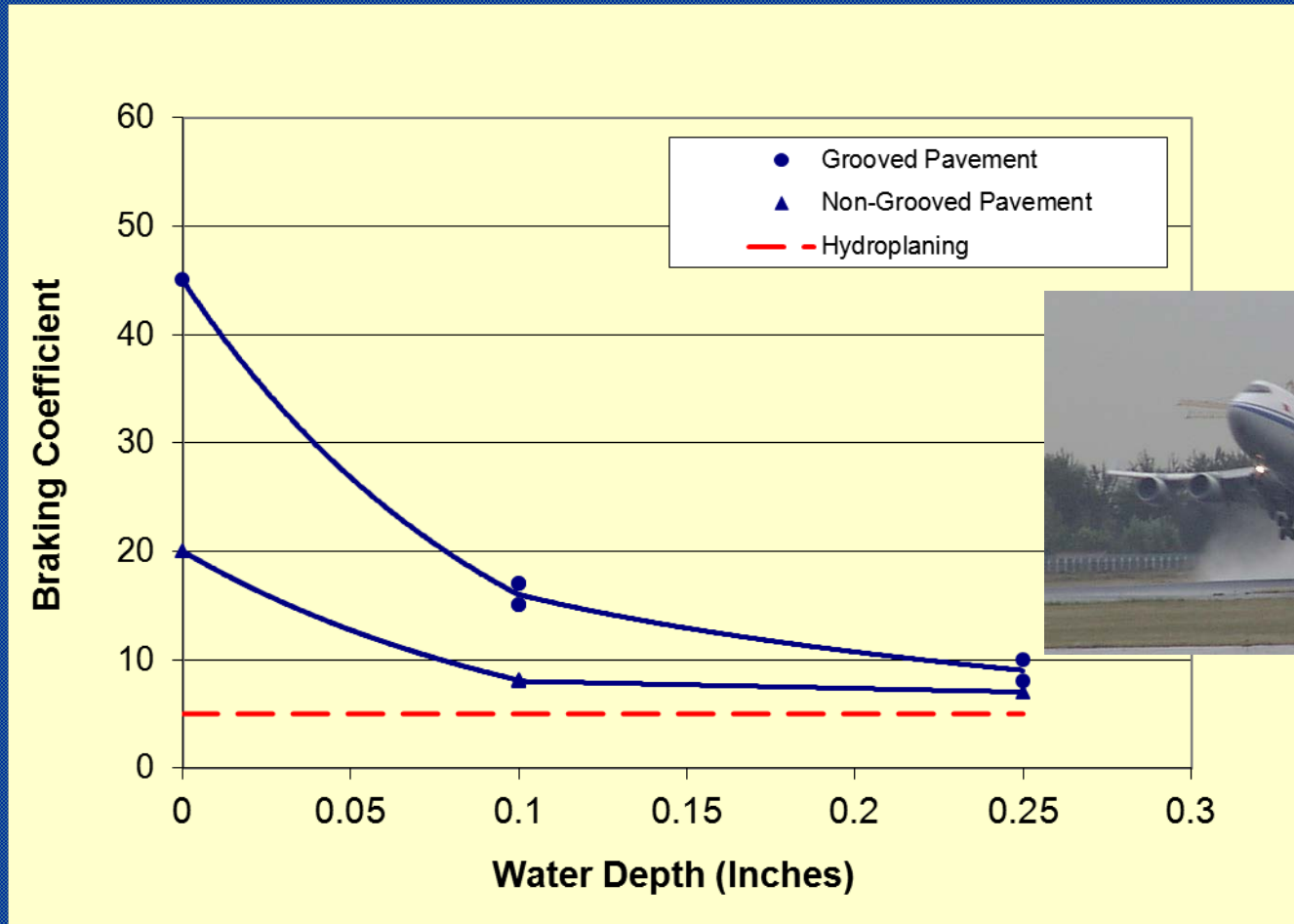
Takeoff Roll at 90 Knots



Takeoff Roll at 110 Knots



Decision Point at 130 Knots Takeoff or Abort



Summary

FAA Full Scale Test Program Braking/Hydroplaning Technical Advances Achieved

- Maximum Braking Data Base
- Asphalt as well as Portland Cement
- Porous Friction Course as well as Grooving
- Benefit of Grooving versus Tire Tread
- Uniformly Puddled Condition
- Groove Spacing up to 4 inches
- Speeds up to 150 Knots

FAA Full Scale Test Program Braking/Hydroplaning Products of the Effort

- Supports Current FAA Grooving Standards.
- Spacing of 1/4 x 1/4 in. Saw-Cut Grooves Extended from 1¼ ins. to 1½ ins.
- Grooving Costs Reduced by an Estimated 7%.
- More Significant Cost Savings Possible with Slightly Greater Increases in Spacing.

FAA Full Scale Test Program Braking/Hydroplaning Products of the Effort (Continued)

- Data Base Can Be Useful to Foreign Aviation Authorities in Supporting the Grooving of Runways in their Respective Countries.
- Data Base Can Support the Establishment of International Guidelines for the Grooving of Runways.

FAA Full Scale Test Program Braking/Hydroplaning

- Briefing and DOT/FAA Technical Reports Available for Download from NAPTF Website
- Google, Bing, or Yahoo
- faa naptf
- About the NAPTF
- Menu on left
- Located under "Downloads", "Safety"

Dynamic Test Track

- Naval Air Engineering Center (NAEC)
- Lakehurst, New Jersey
- High Speed Films of Tests Follow: