The Benefit of Runway Grooving

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FAA/Asphalt Institute Airport Pavement Workshop
October 18-20, 2011
Newport Beach, California

SRA INTERNATIONAL, INC.

FEDERAL AVIATION ADMINISTRATION

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

- <u>Not</u> <u>Used</u> to Provide an <u>Increase</u> in the <u>Friction</u> <u>Capability</u> of the Pavement Surface

Friction

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

Runway Grooving

- Provides <u>Forced</u> <u>Water</u> <u>Escape</u> 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)

Rule of Thumb for Water Covered Runways Servicing Aircraft Operations

- 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)

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

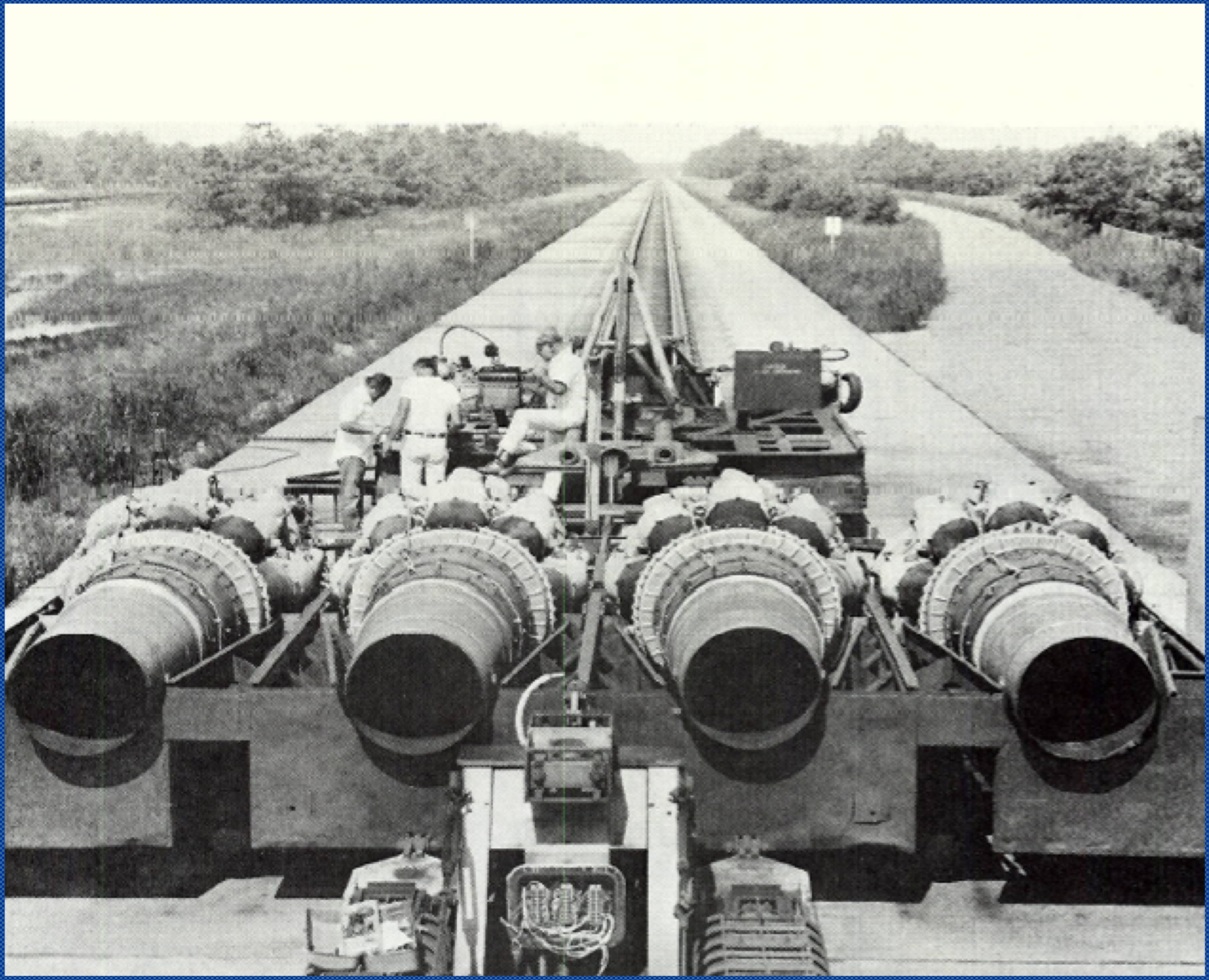
FAA Full Scale Test Program Braking/Hydroplaning

- 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

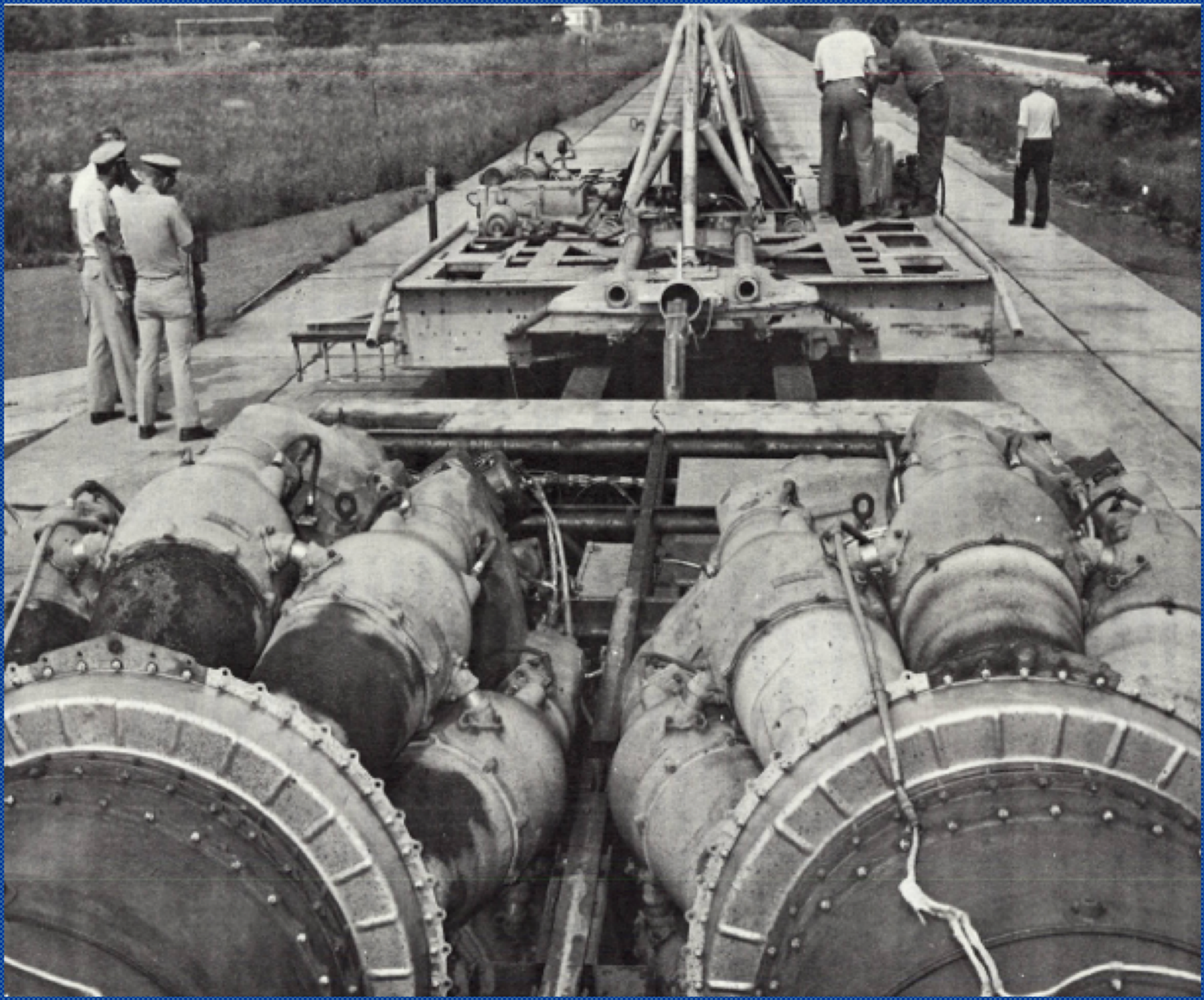
FAA Full Scale Test Program
Braking/Hydroplaning
Water Depth Conditions on Pavement

- Wet 0.00 in. Standing Water
- Puddled 0.10 in. Standing Water
- Flooded 0.25 in. Standing Water

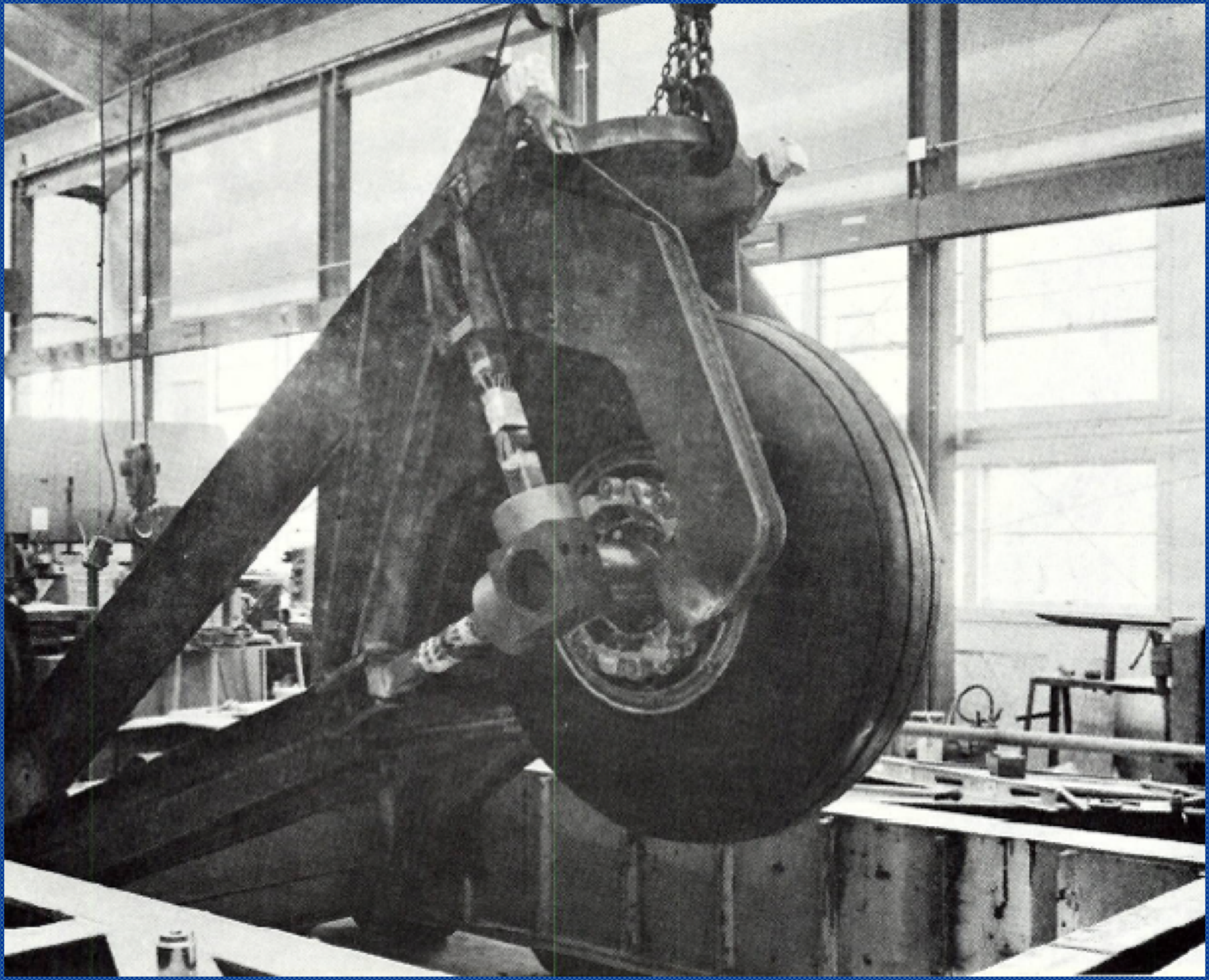
Launch End of Test Track



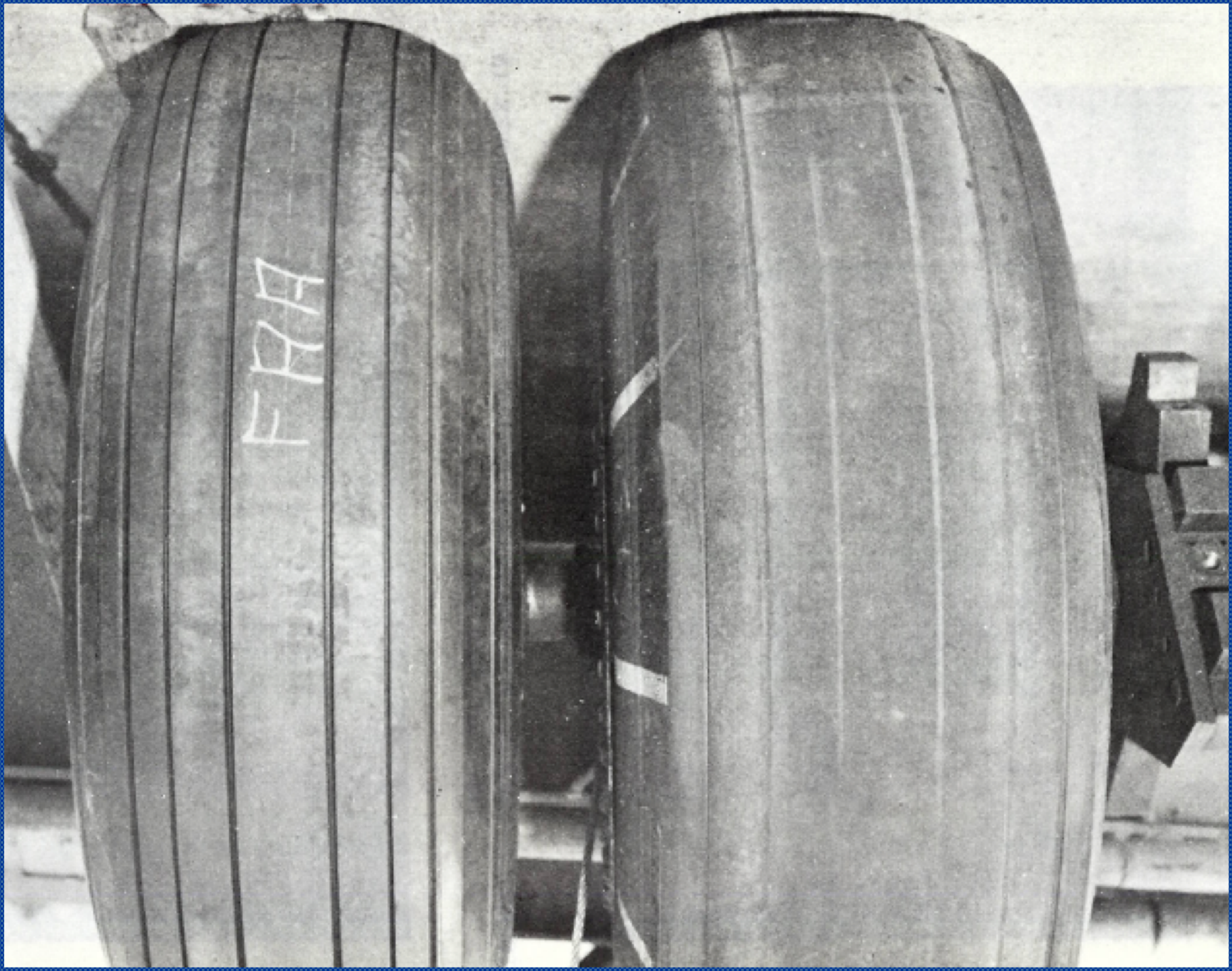
Launch End of Test Track



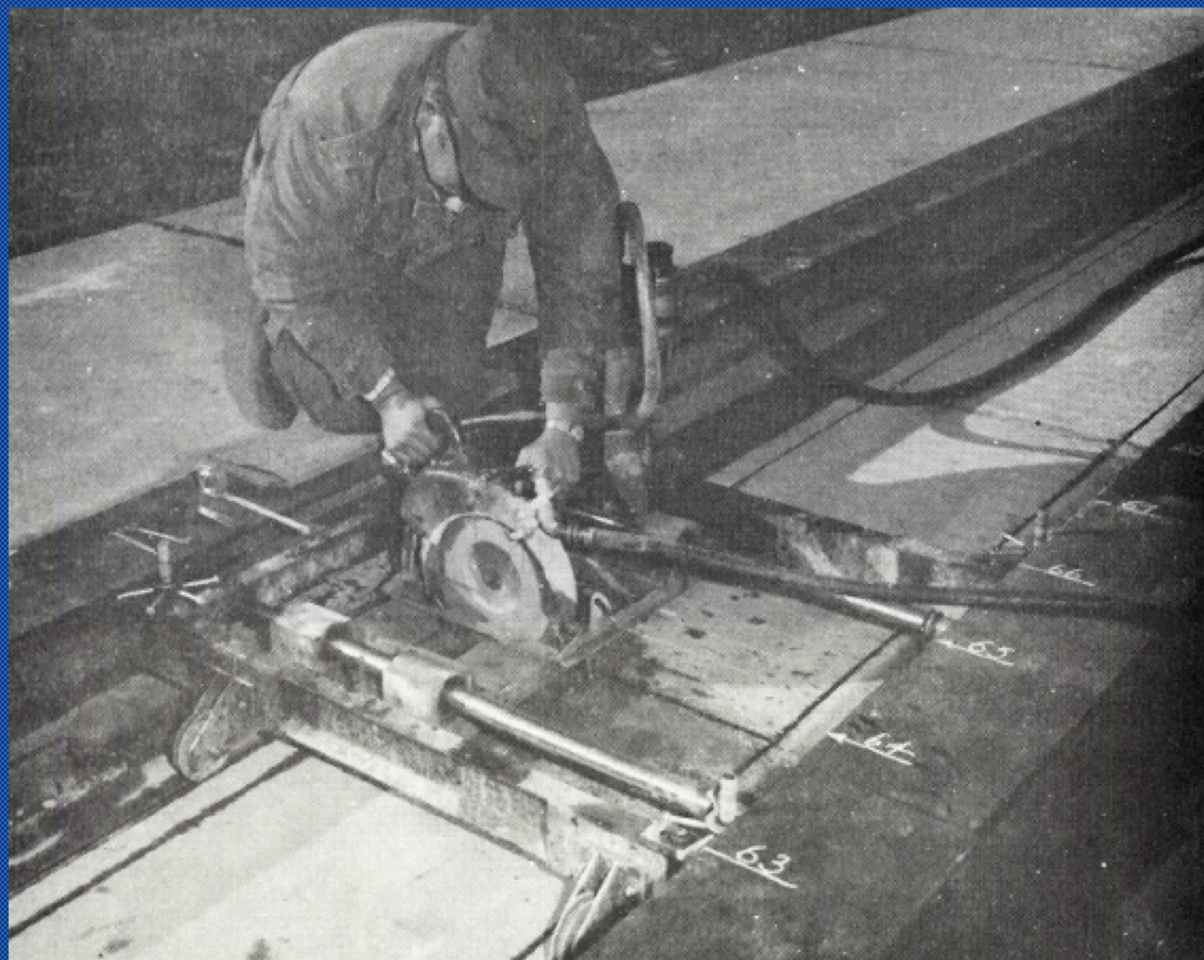
Dynamometer with Tire-Wheel Assembly



New and Worn Tire Tread

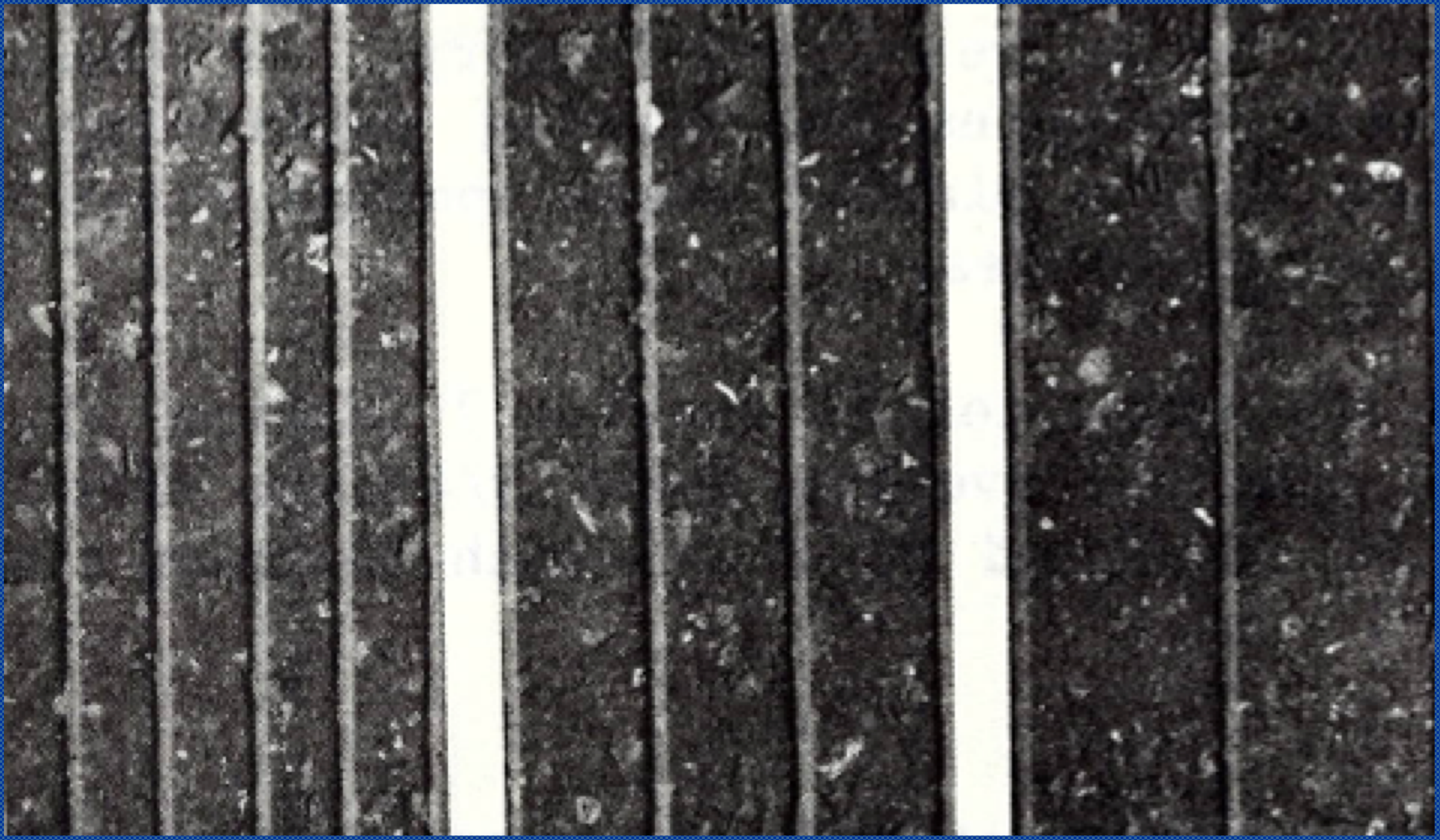


Saw Cutting Grooves in the Test Pavement

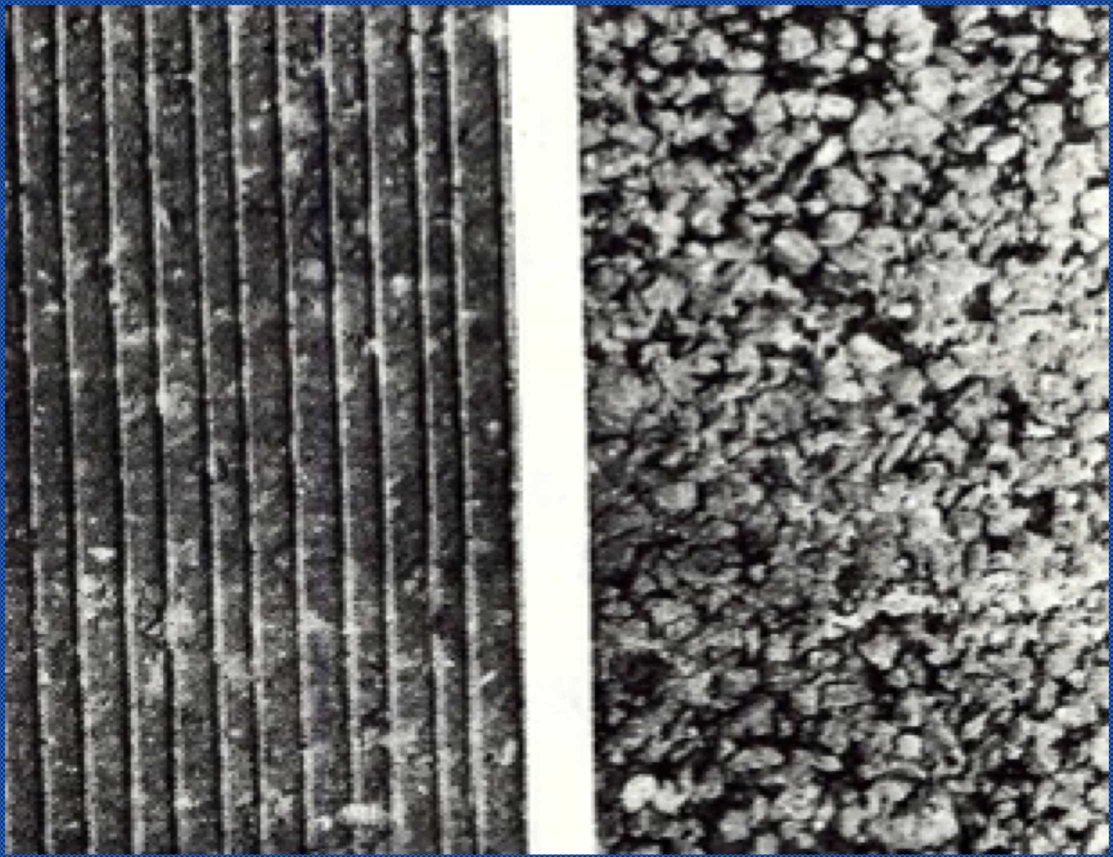


Test Pavement at the Recovery End of the Test Track

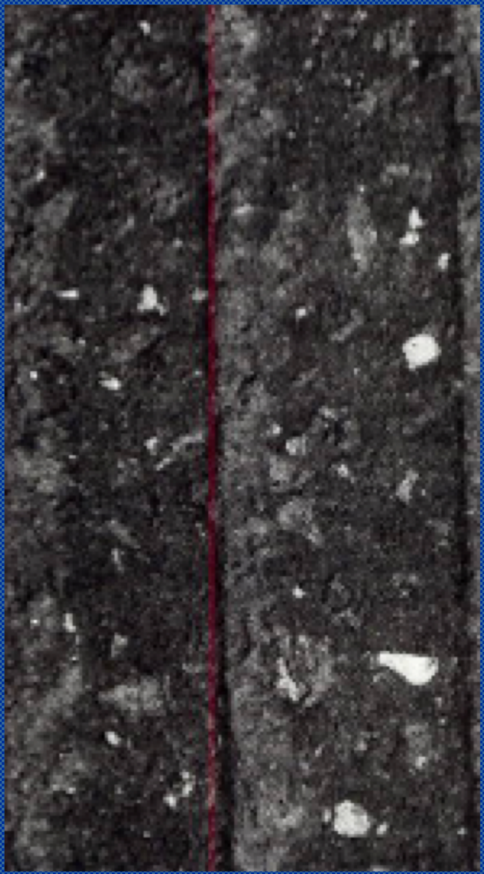
1/4 x 1/4 in. Grooves Spaced at 1 1/4 , 2, and 3 ins.



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



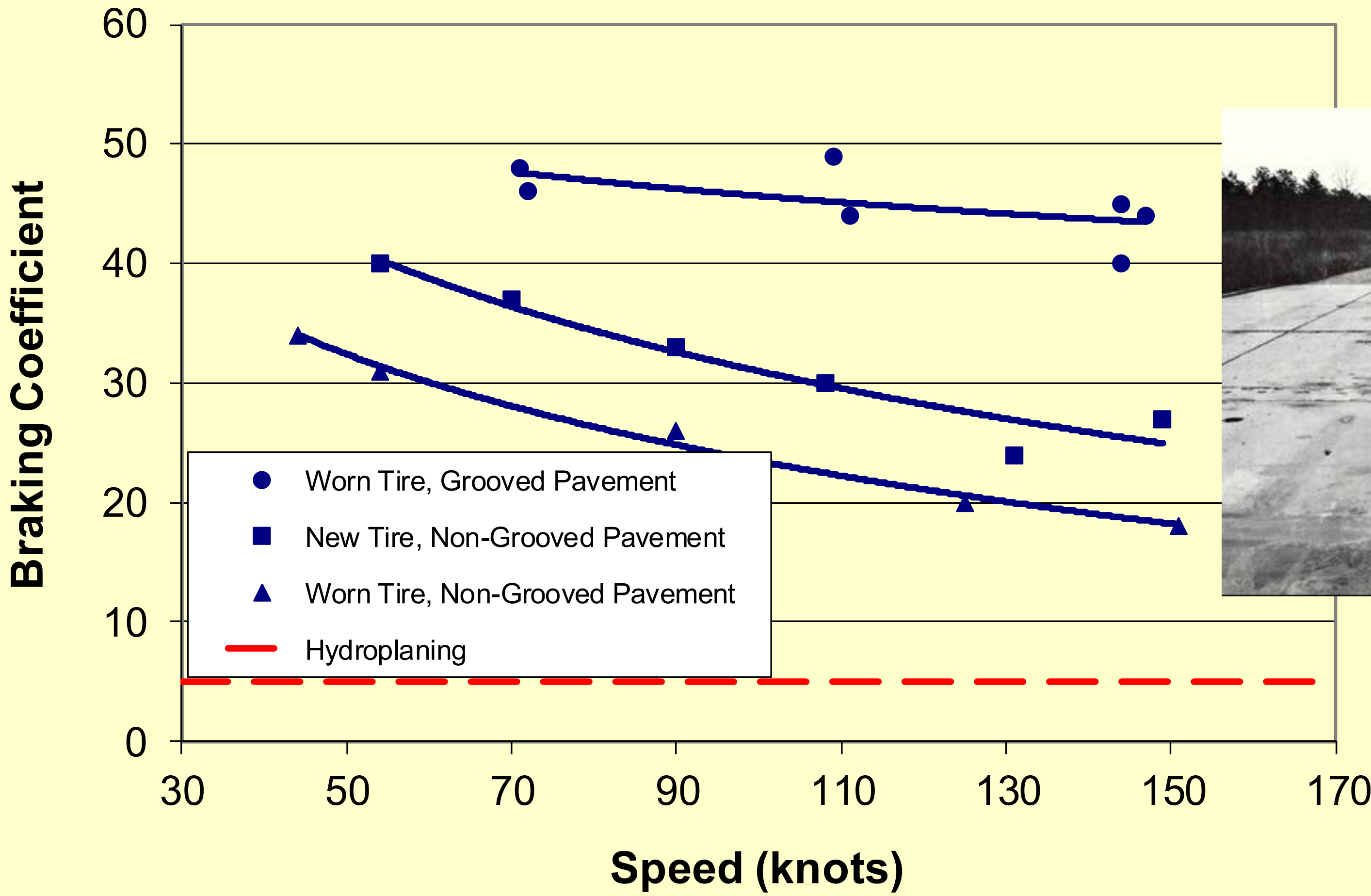
Experimental Percussive Grooves at 3 in. Spacing

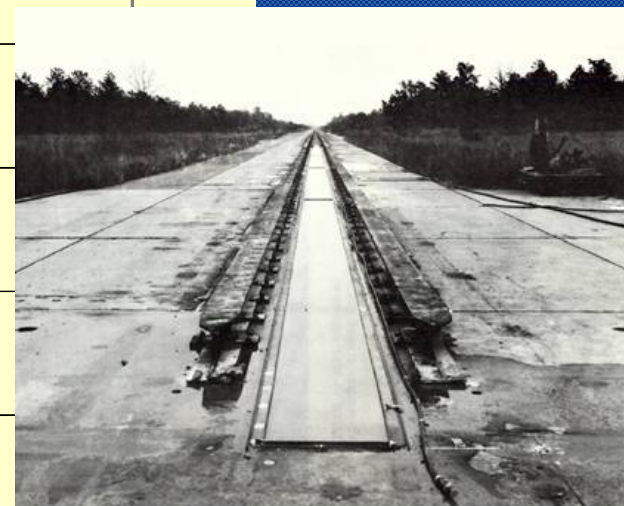


Grooved Pavement

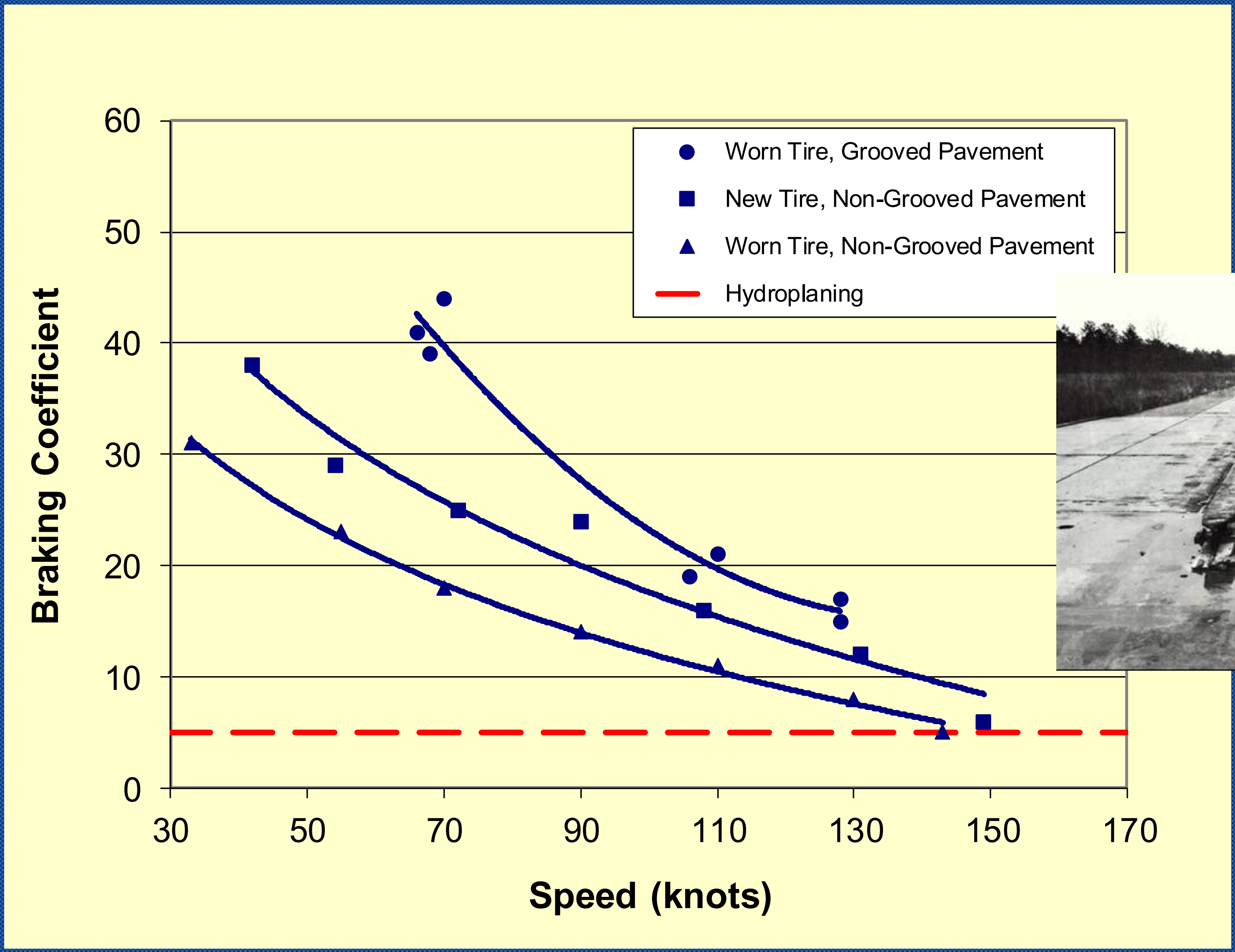
- FAA Standard 1/4 x 1/4 Saw-Cut Grooves Spaced at 1½ inches
- Represented by Curve Fits between Data Points for 1¼ inch and 2 inch Spacing

Braking on a Wet Asphalt Pavement

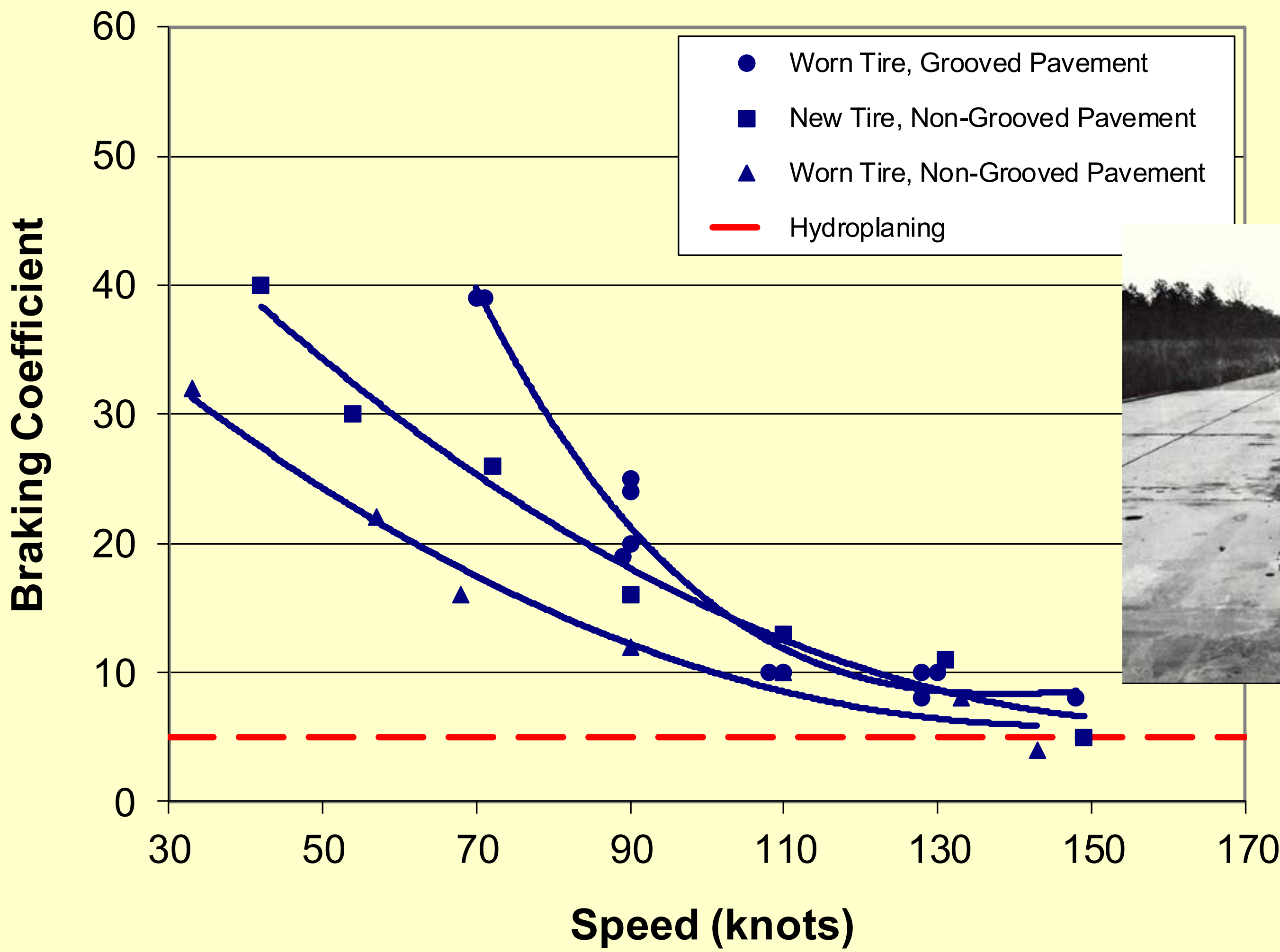


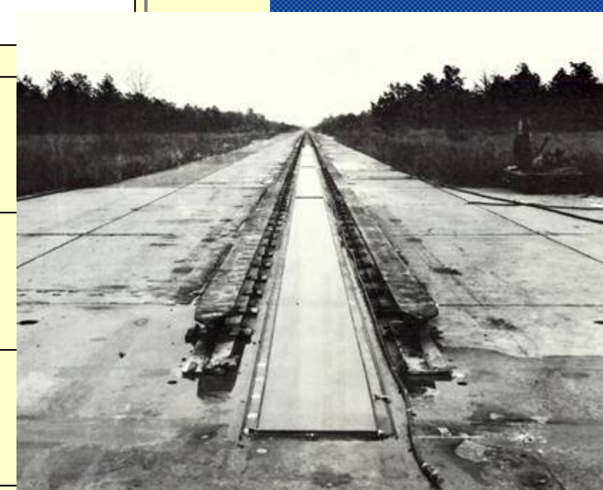


Braking on a Puddled Asphalt Pavement

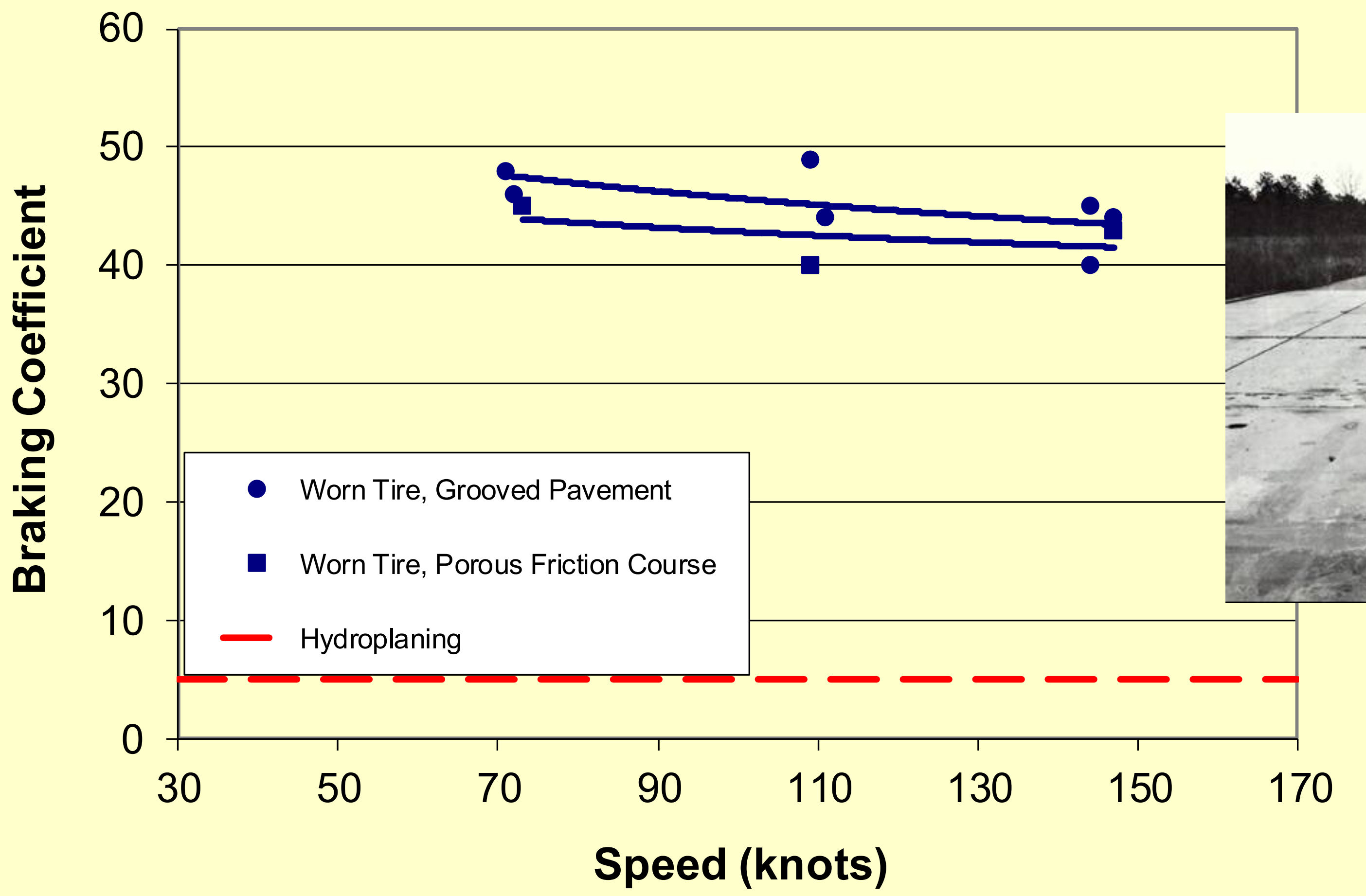


Braking on Flooded Asphalt Pavement

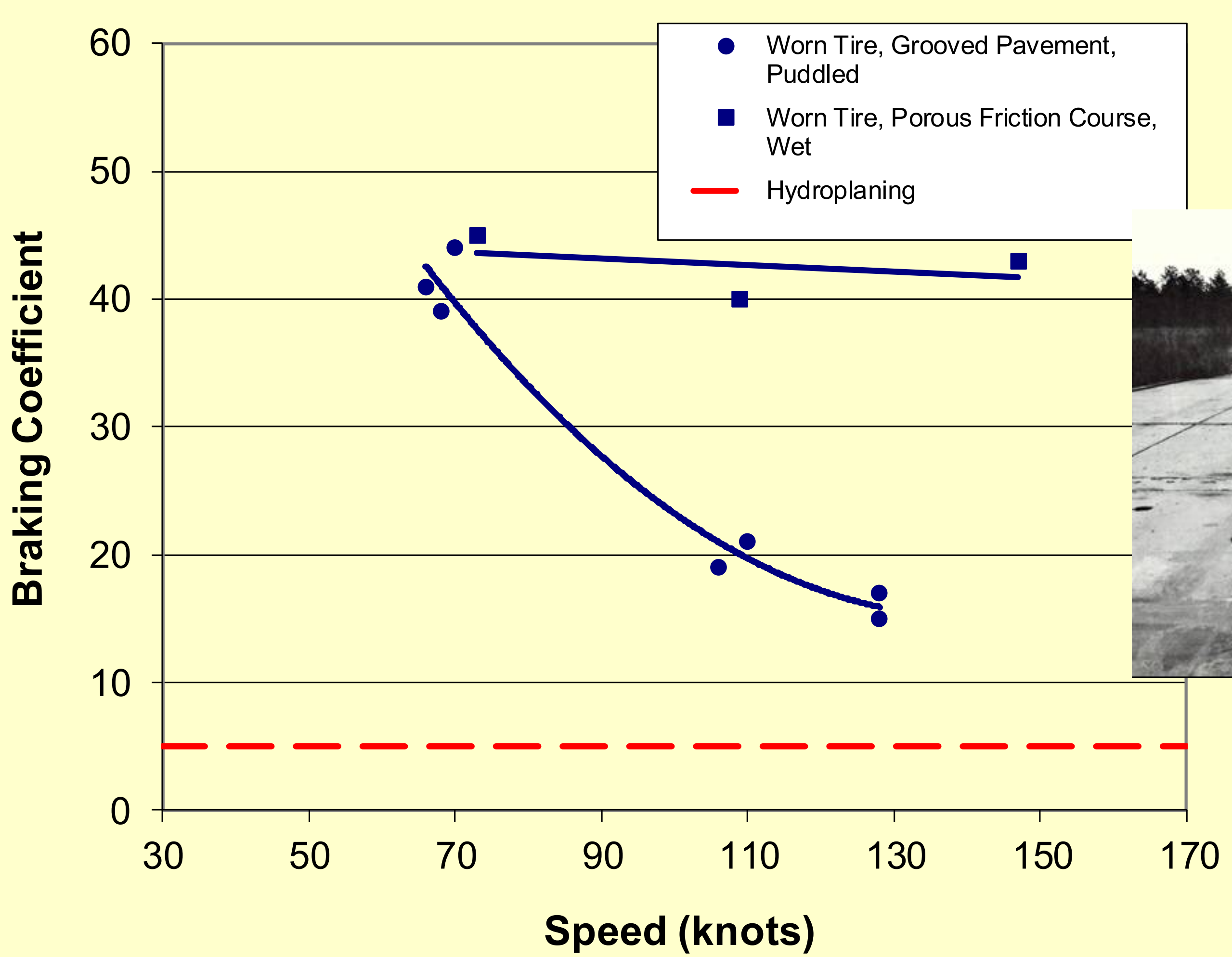


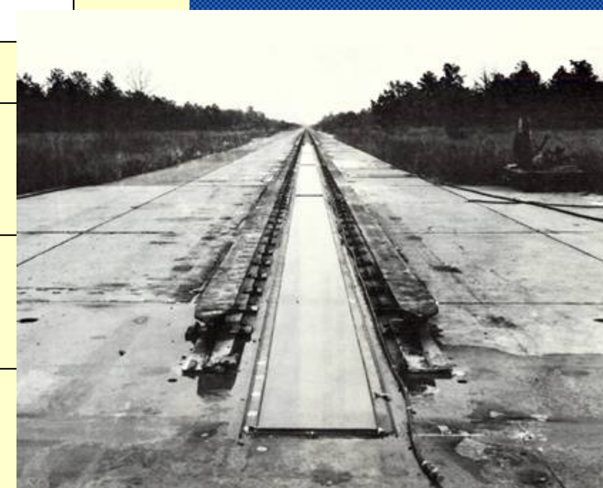


Braking on a Wet Asphalt Pavement

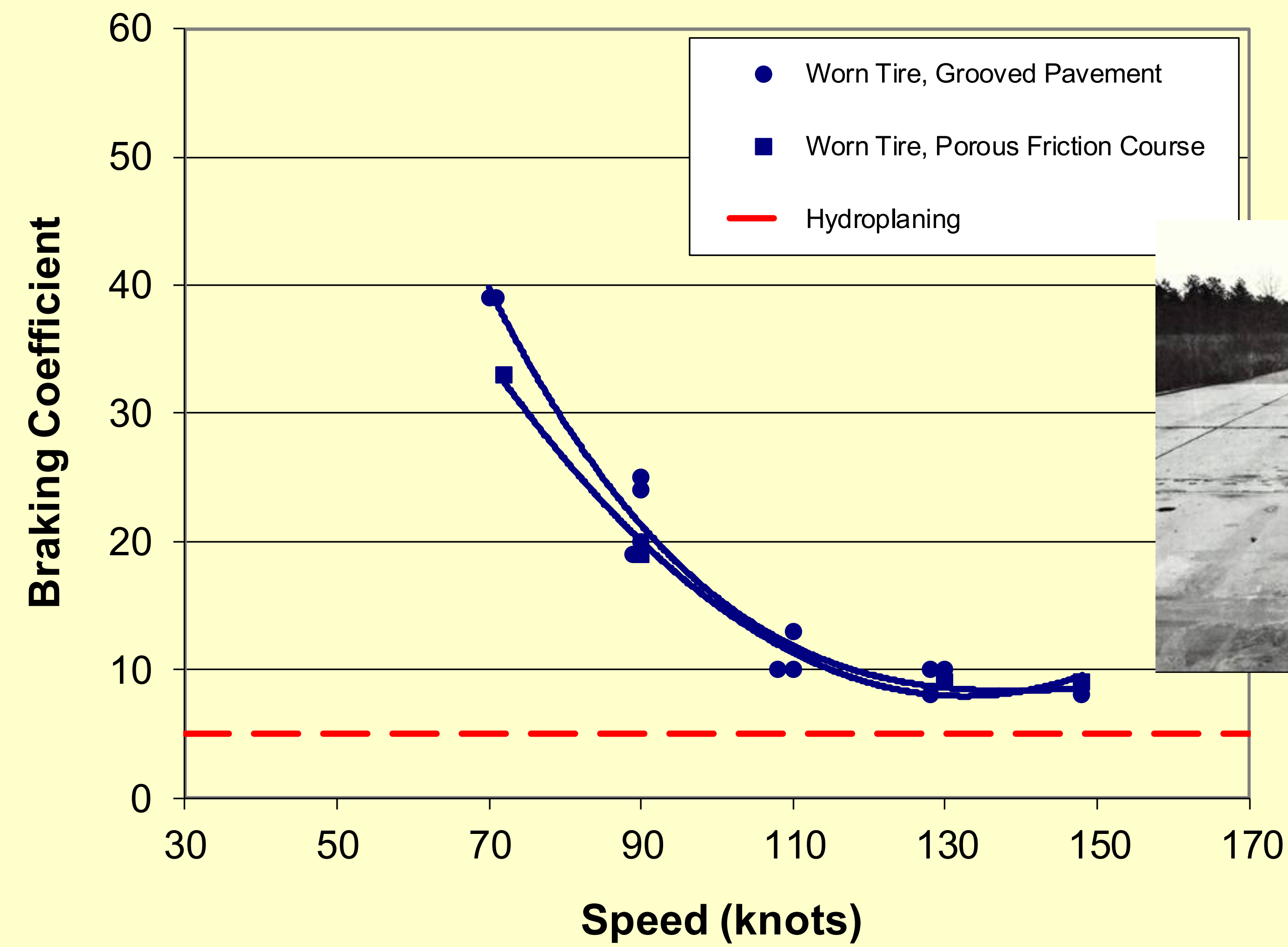


Braking on an Asphalt Pavement Under a Heavy Downpour





Braking on an Asphalt Pavement Under a Heavy Downpour (Flooded)



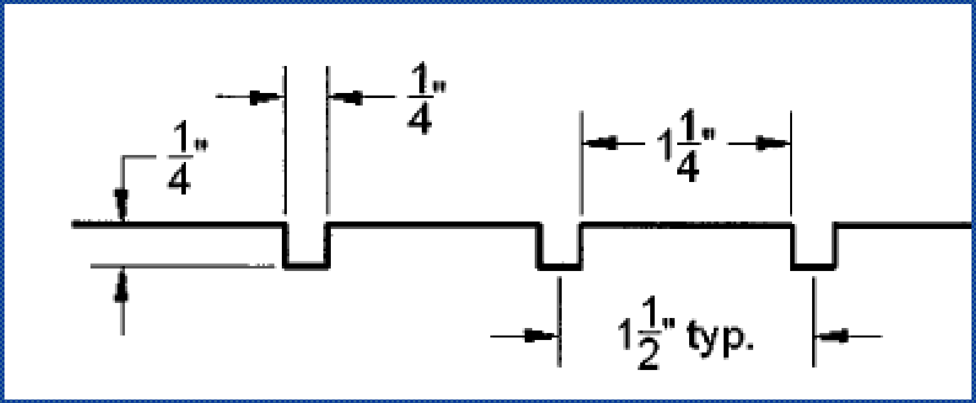
Essentials of an Aircraft Braking/Hydroplaning Test System

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

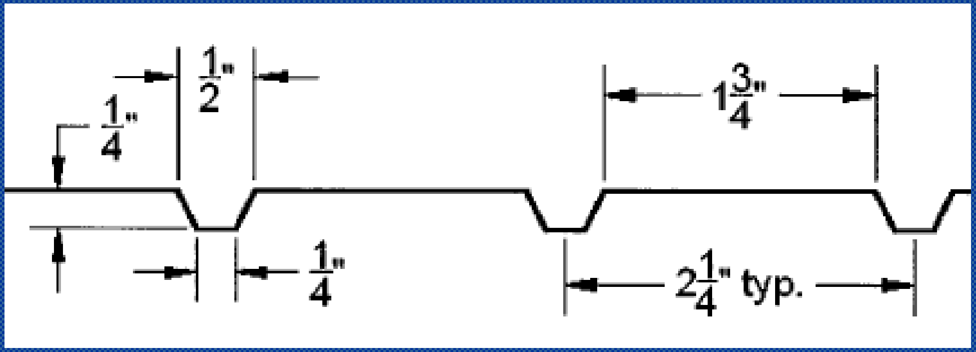
Aircraft Braking/Hydroplaning Test System Scenarios

- 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

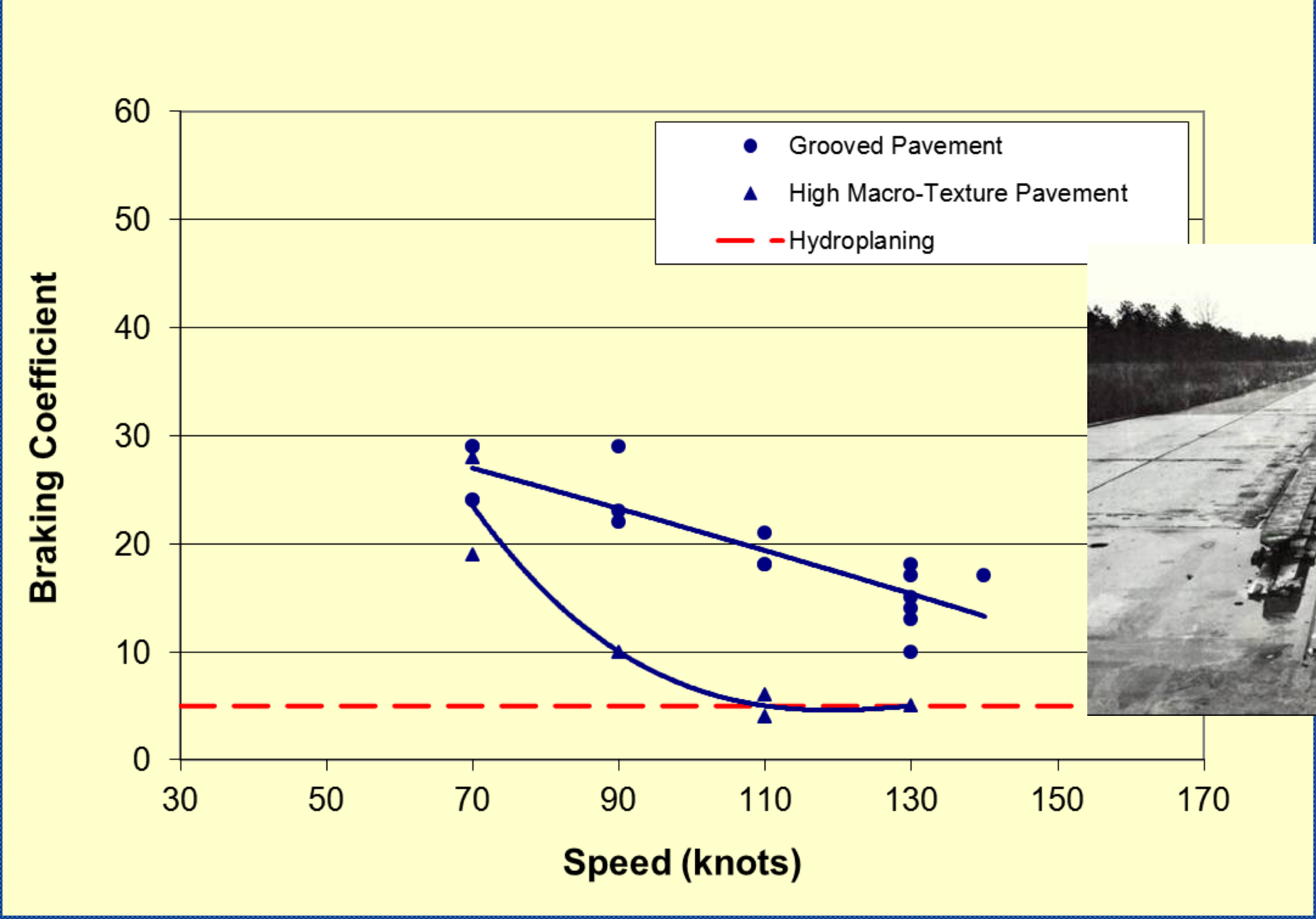


Standard



Proposed

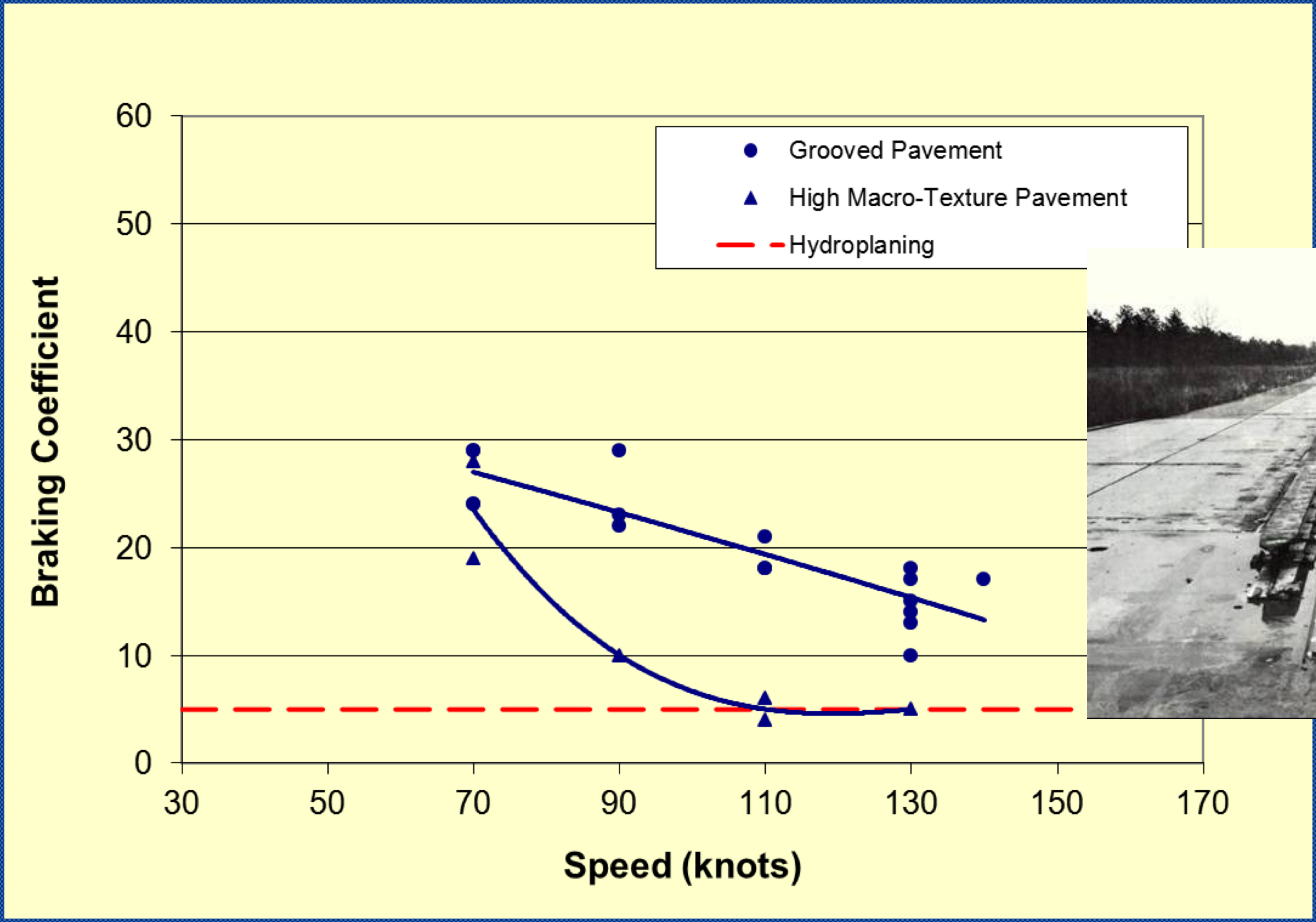
FAA Standard Groove Pattern vs. High Macrotexture - New Tire on a Puddled Portland Cement Concrete Pavement



Landing of a Jet Transport Aircraft on a Stone Matrix Asphalt (SMA) Runway under Rainfall Conditions

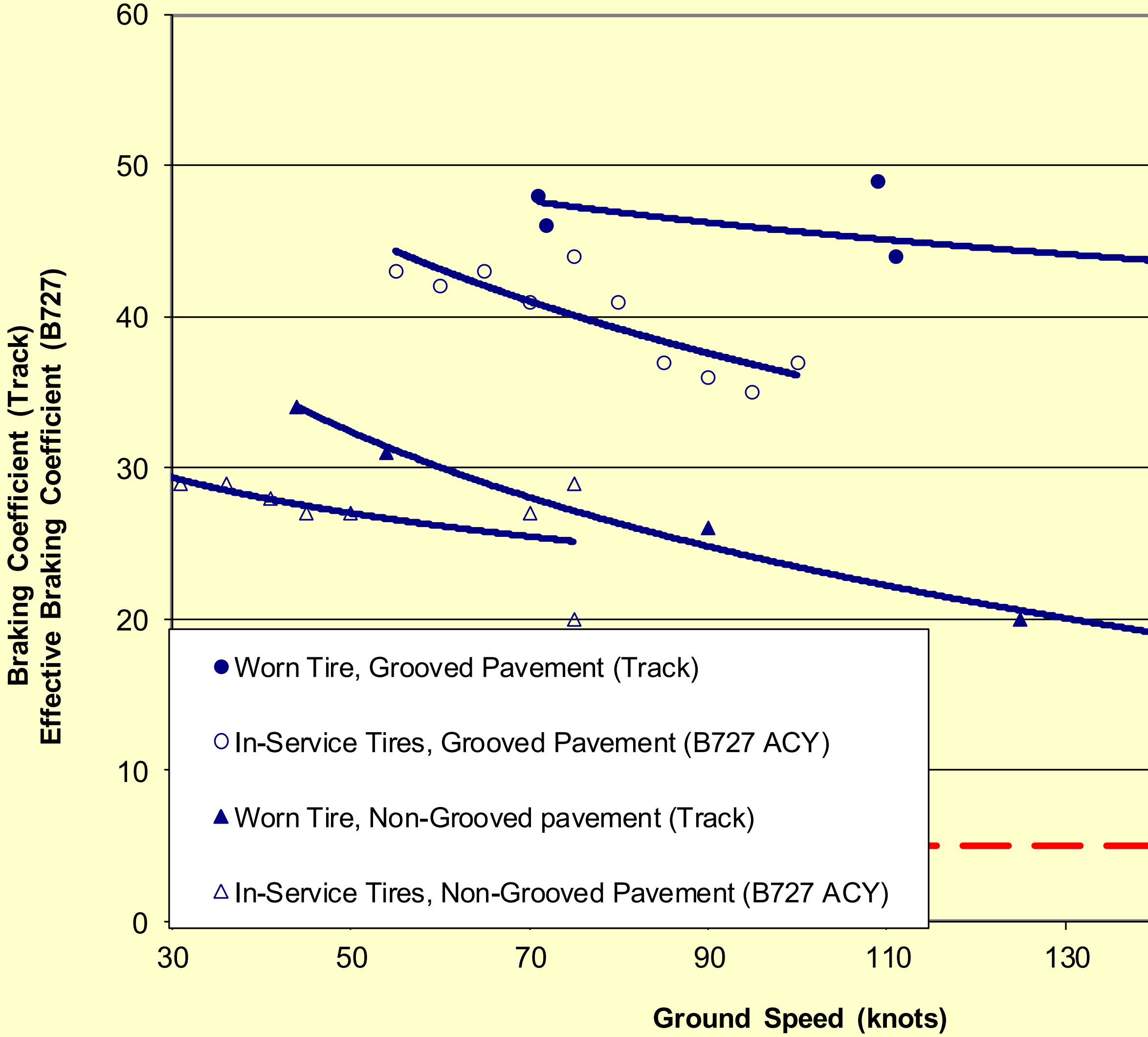
Takeoff of a Jet Transport Aircraft on a Stone Matrix Asphalt (SMA) Runway under Rainfall Conditions

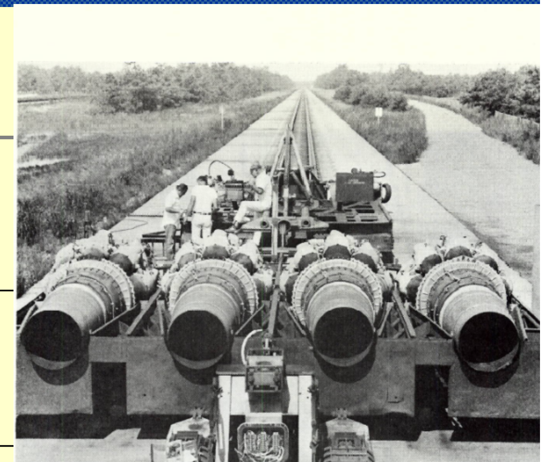
FAA Standard Groove Pattern vs. High Macrotexture - New Tire on a Puddled Portland Cement Concrete Pavement



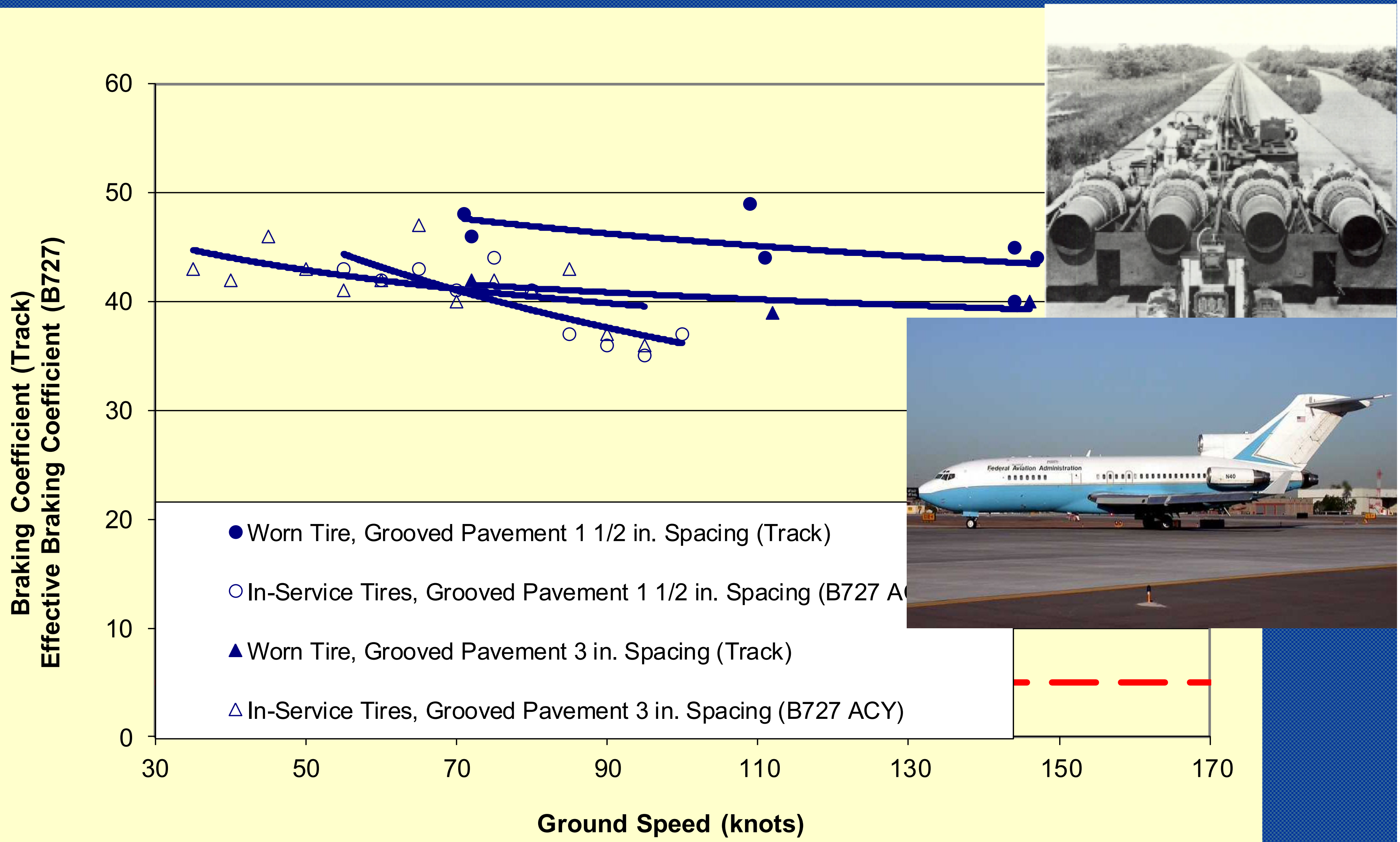
Relationship between Results on the Test Track and Performance of the Aircraft on a Runway

Braking on a Wet Asphalt Pavement

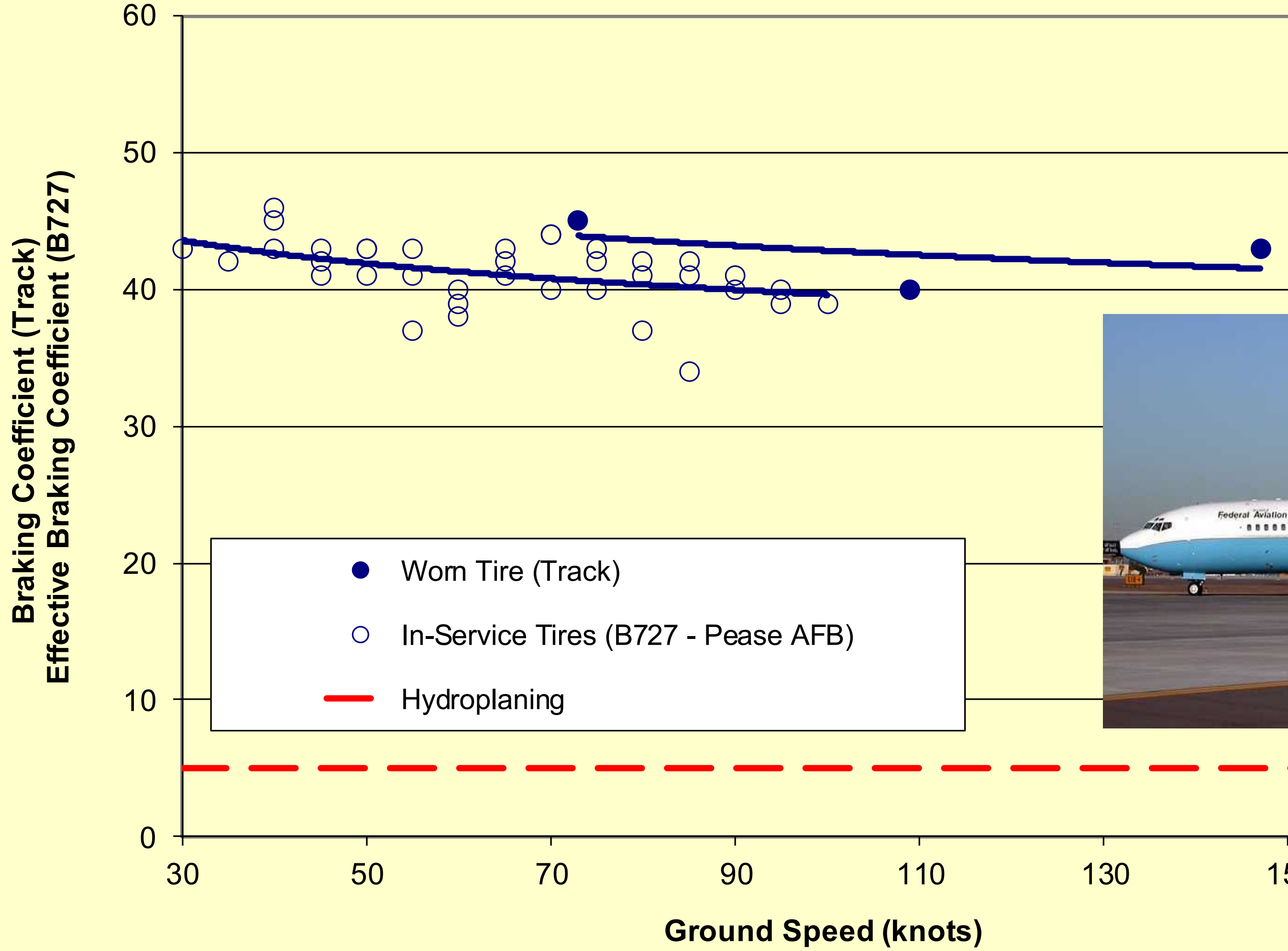


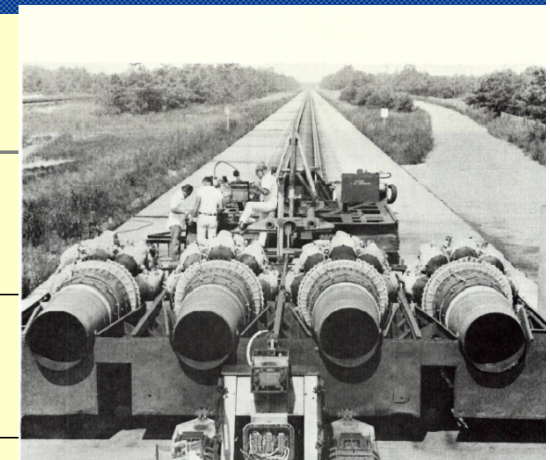


Braking on a Wet Asphalt Pavement



Braking on Wet Porous Friction Course





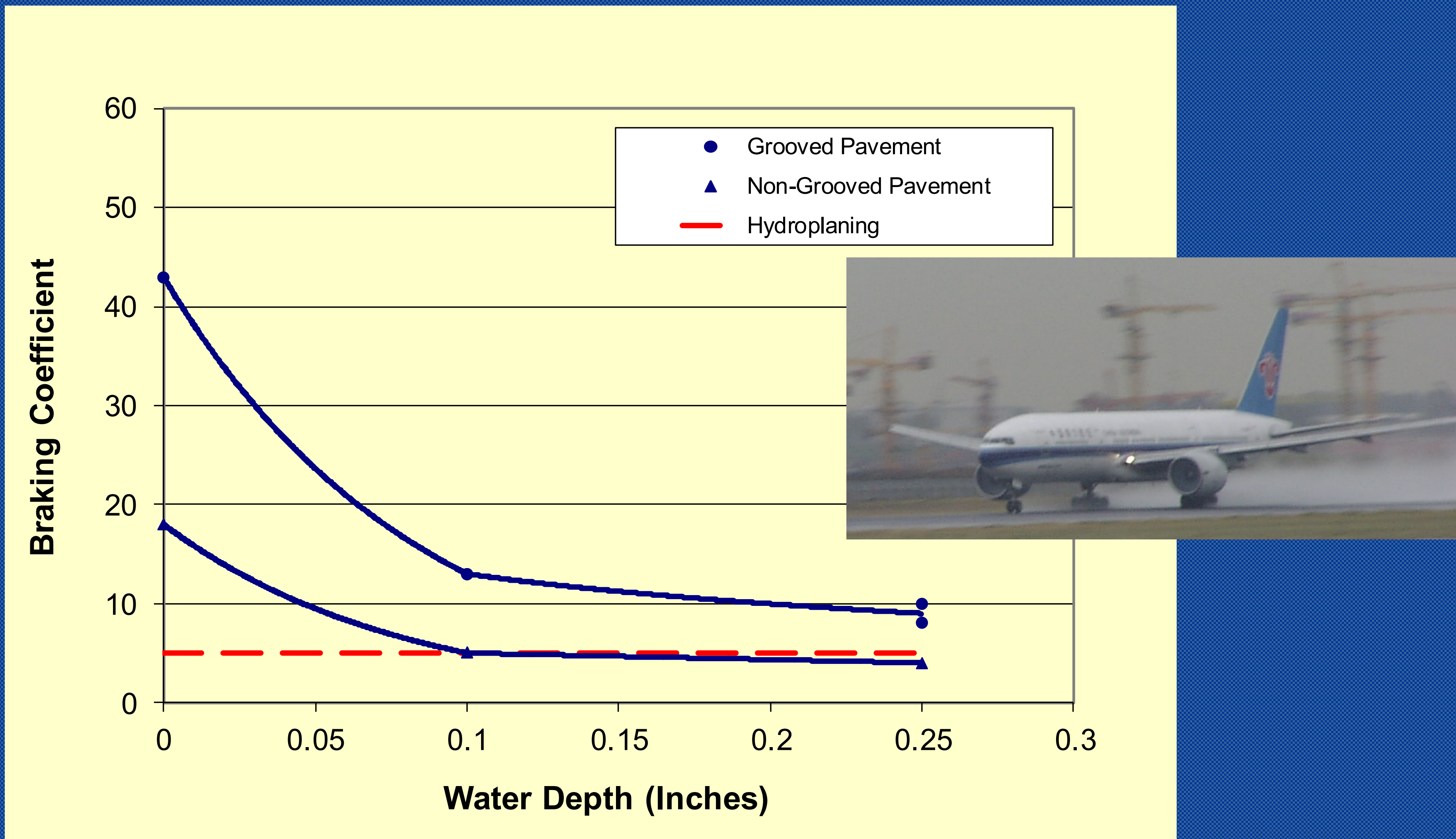
Dynamic Test Track Data Can Be Used to Simulate Tire-Pavement Interaction During the Landing and Takeoff of a Jet Transport Aircraft with Worn Tires on a Runway under Rainfall Conditions.

Inference Drawn from Simulation on Asphalt Pavement

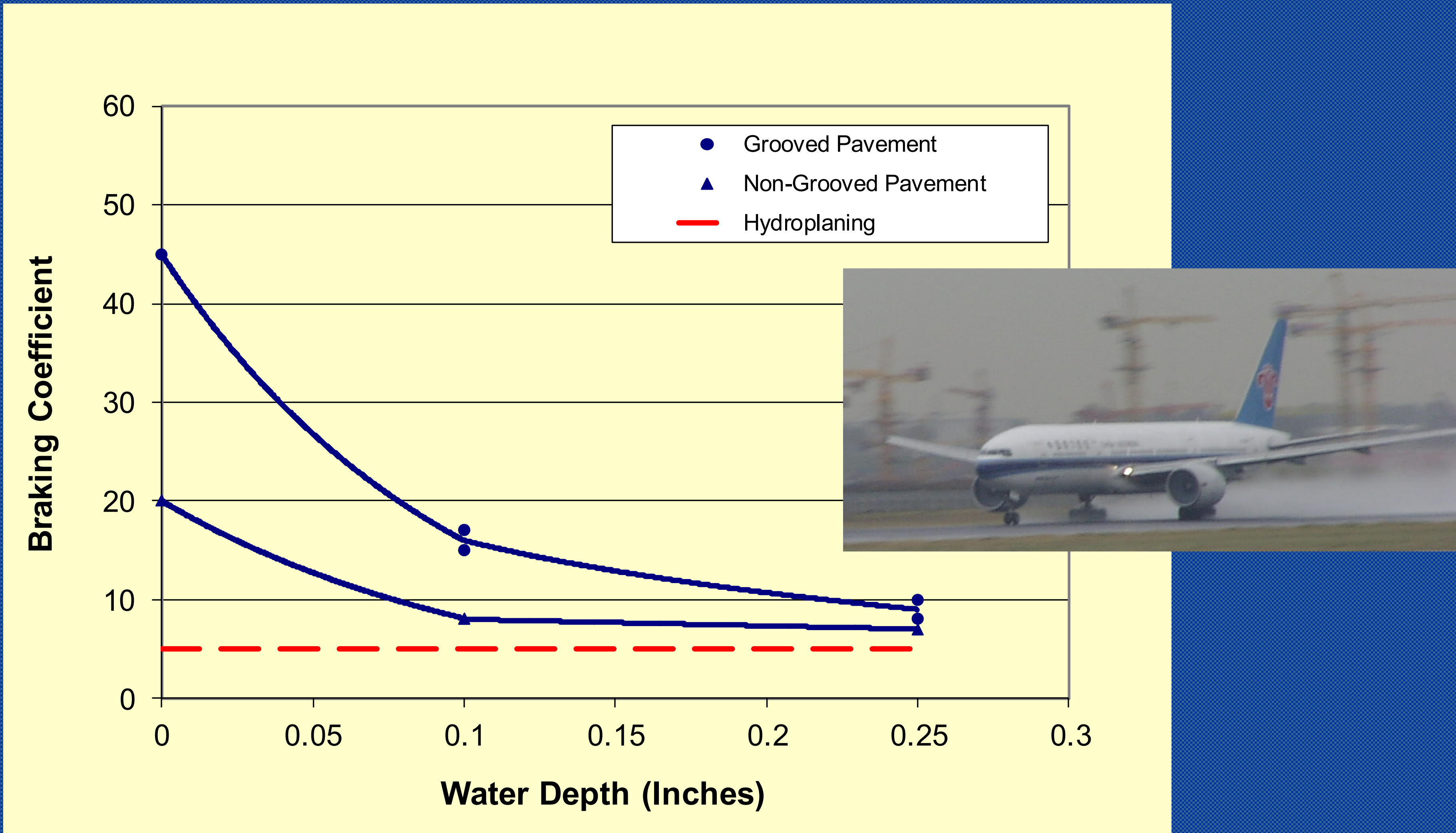
- Runway Grooving Offers the Potential to Double The Magnitude of Tire-Pavement Interaction for Jet Transport Aircraft Operating on Water Covered Runways.

Landing

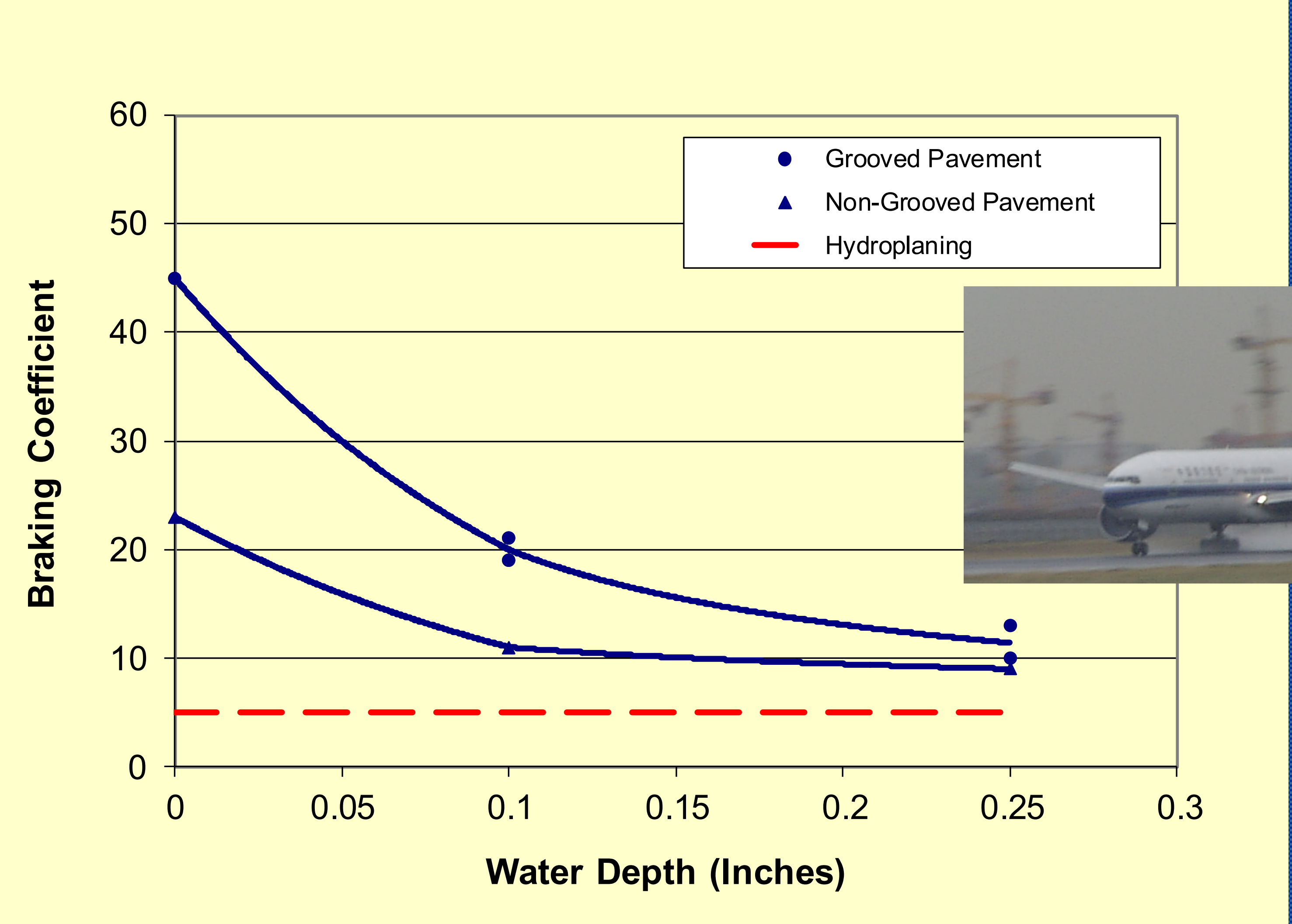
Fast Touchdown at 150 Knots



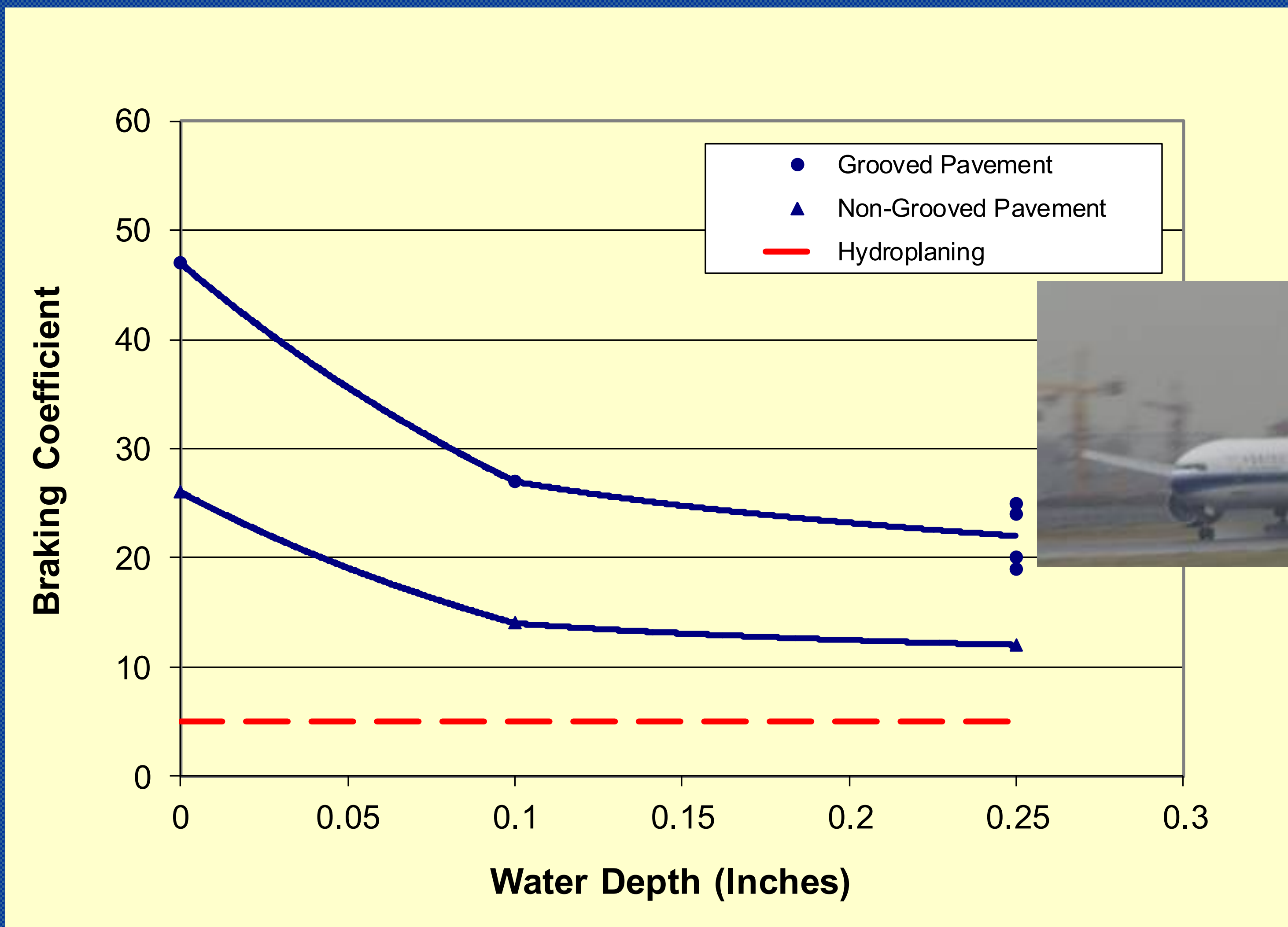
Touchdown at 130 Knots



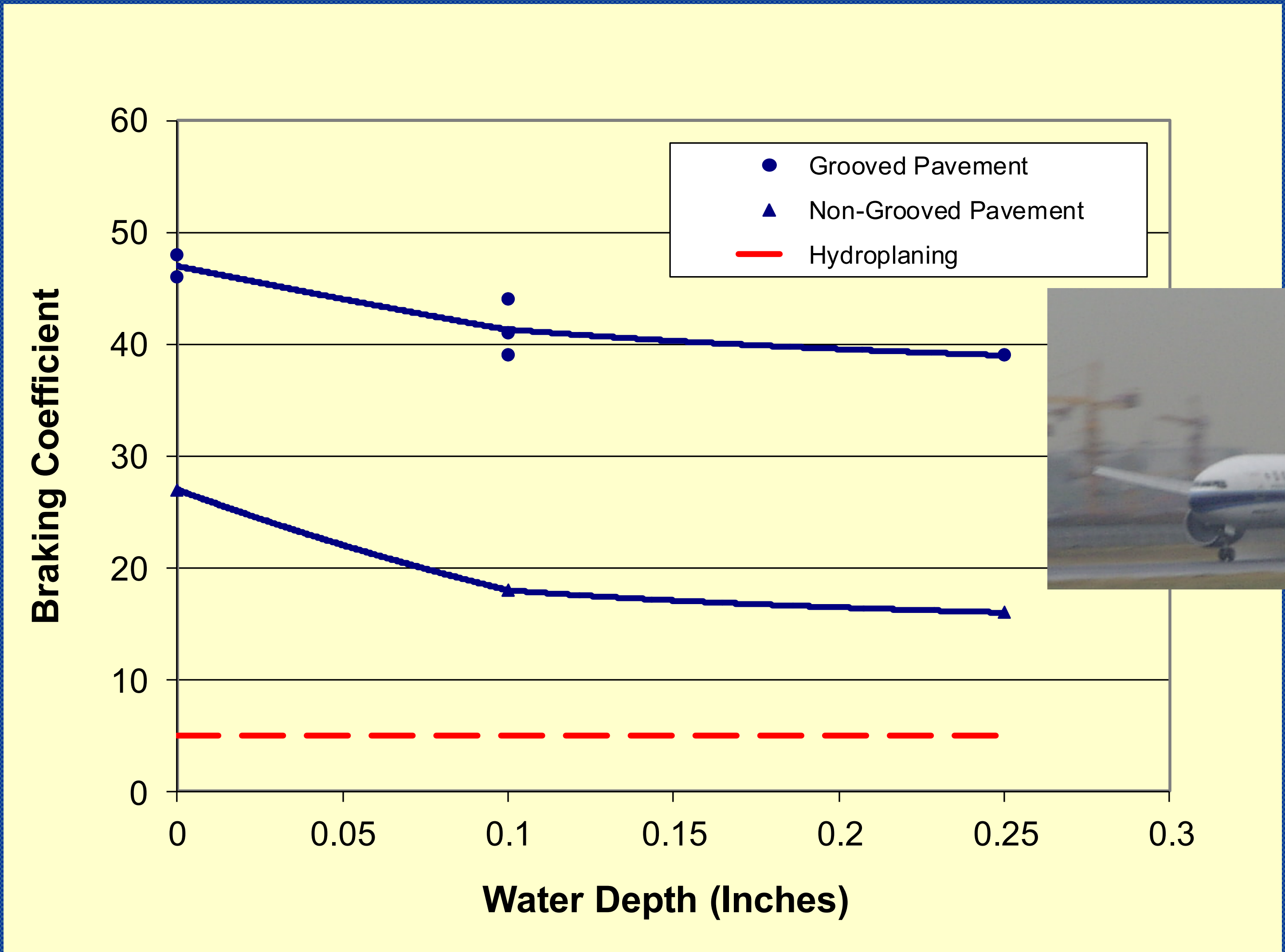
Braking at 110 Knots



Braking at 90 Knots

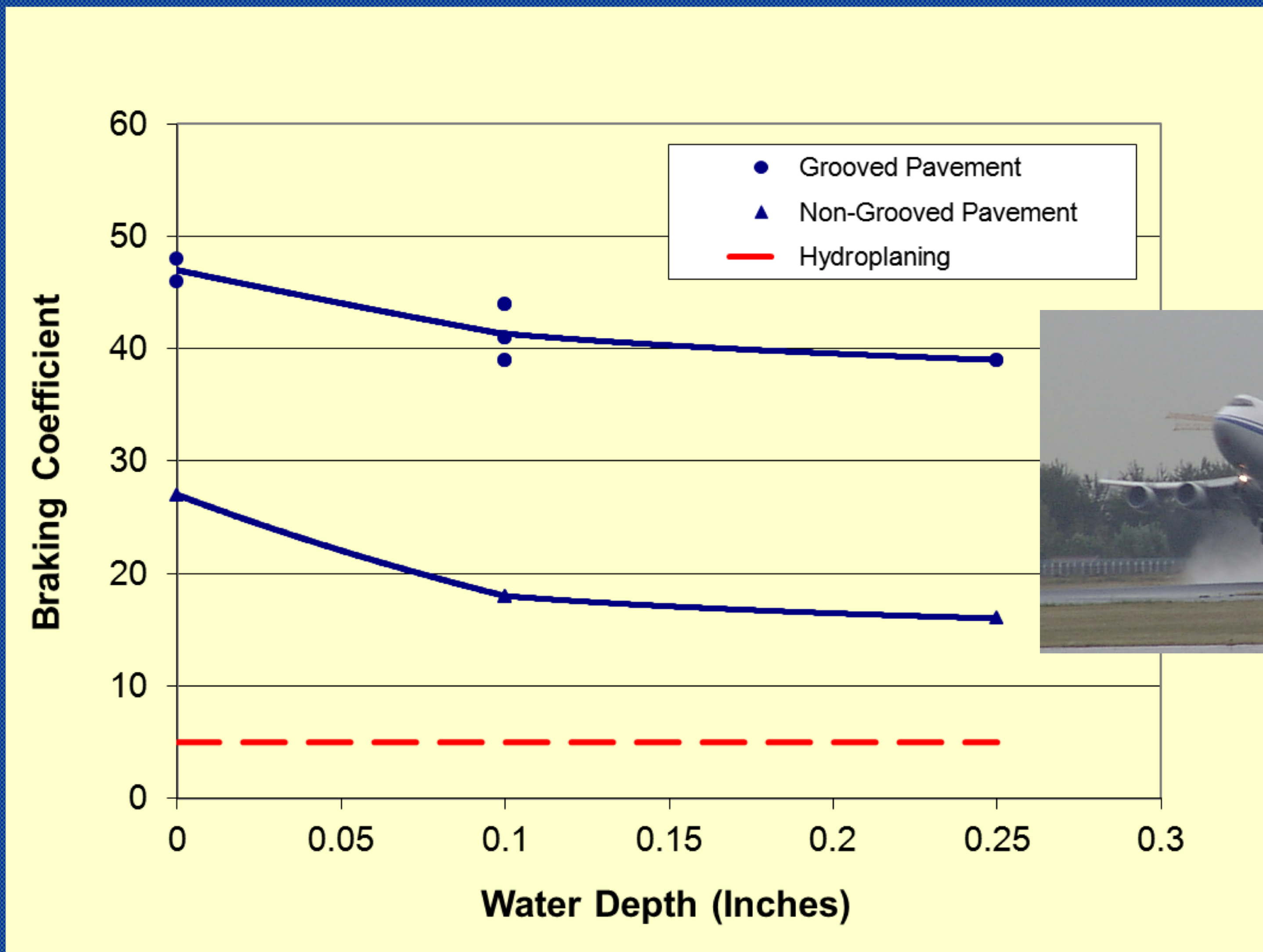


Braking at 70 Knots, Approaching High Speed Turnoff

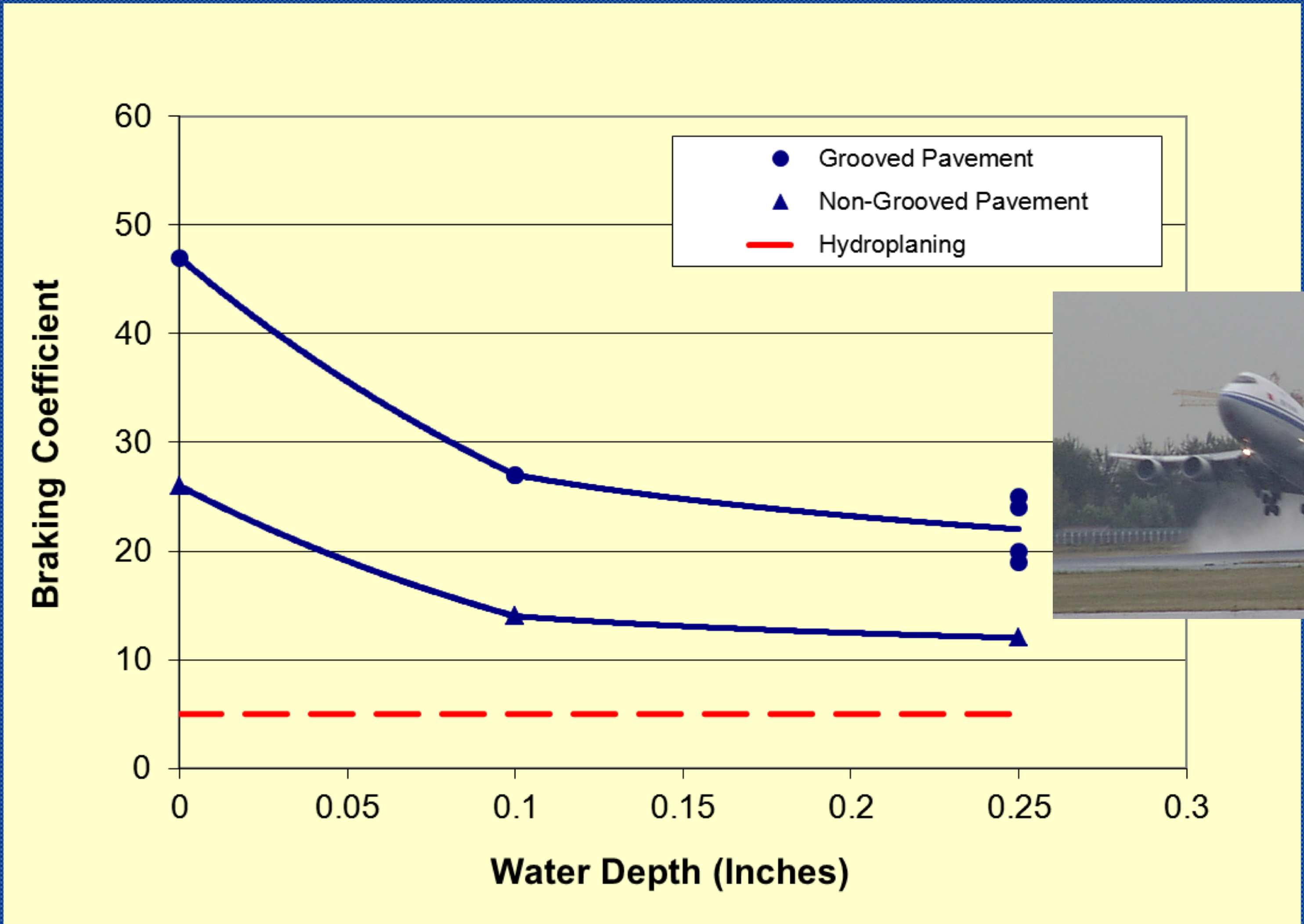


Takeoff

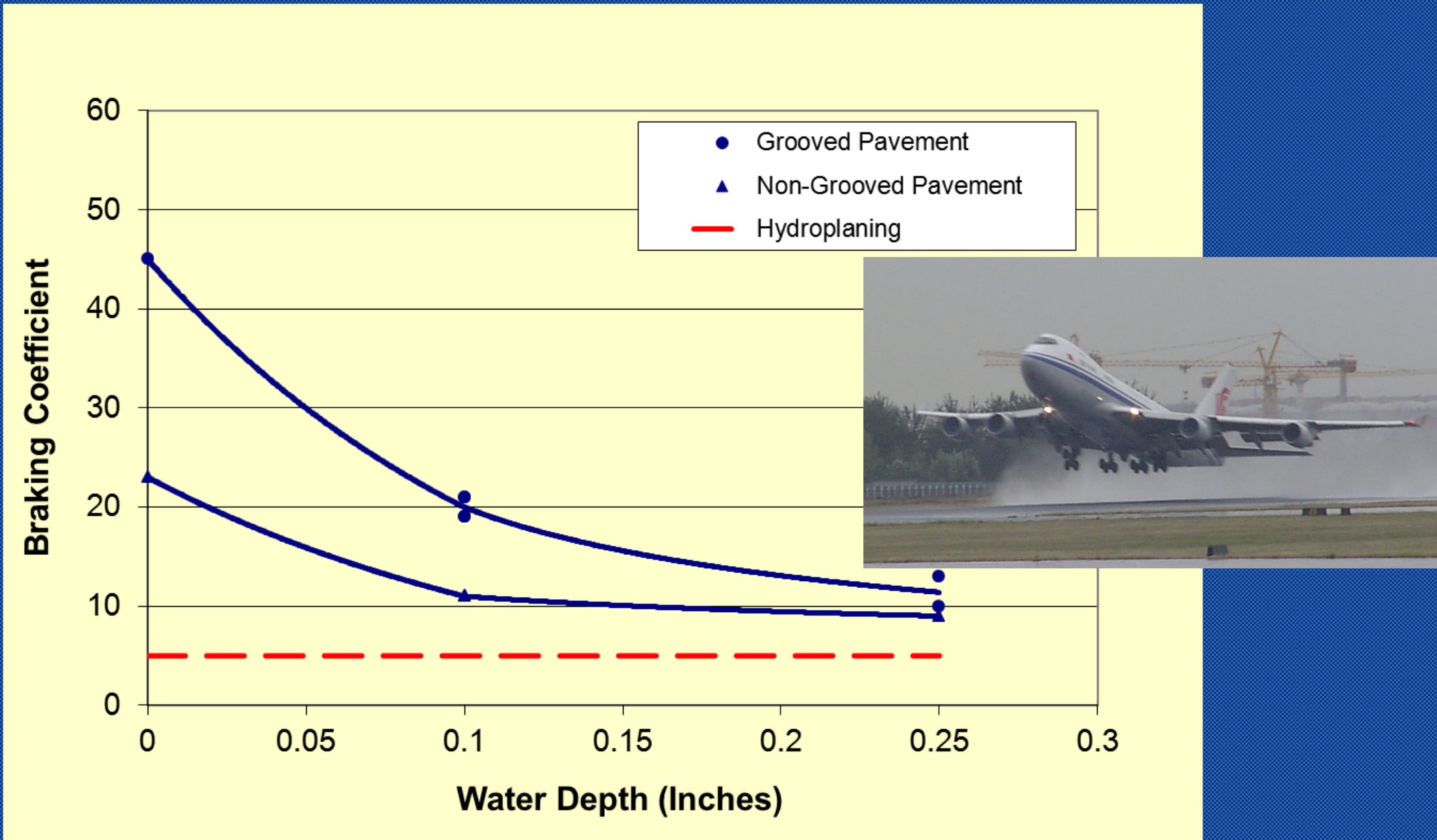
Takeoff Roll at 70 Knots



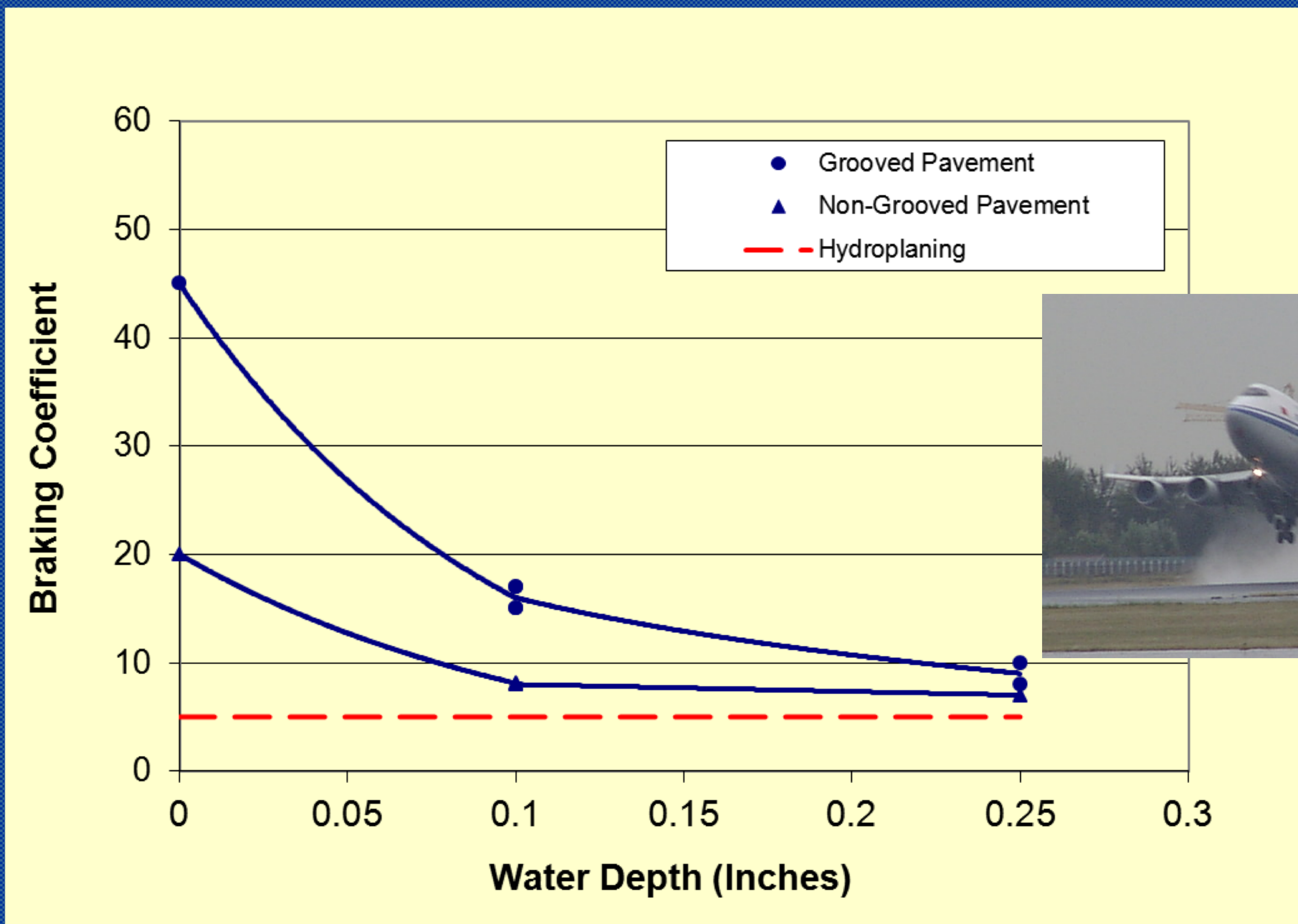
Takeoff Roll at 90 Knots



Takeoff Roll at 110 Knots



Decision Point at 130 Knots
Takeoff or Abort



Dynamic Test Track Data Could Be Used to Recover Lost Capacity More Rapidly at Many Airports Following Periods of Rainfall.

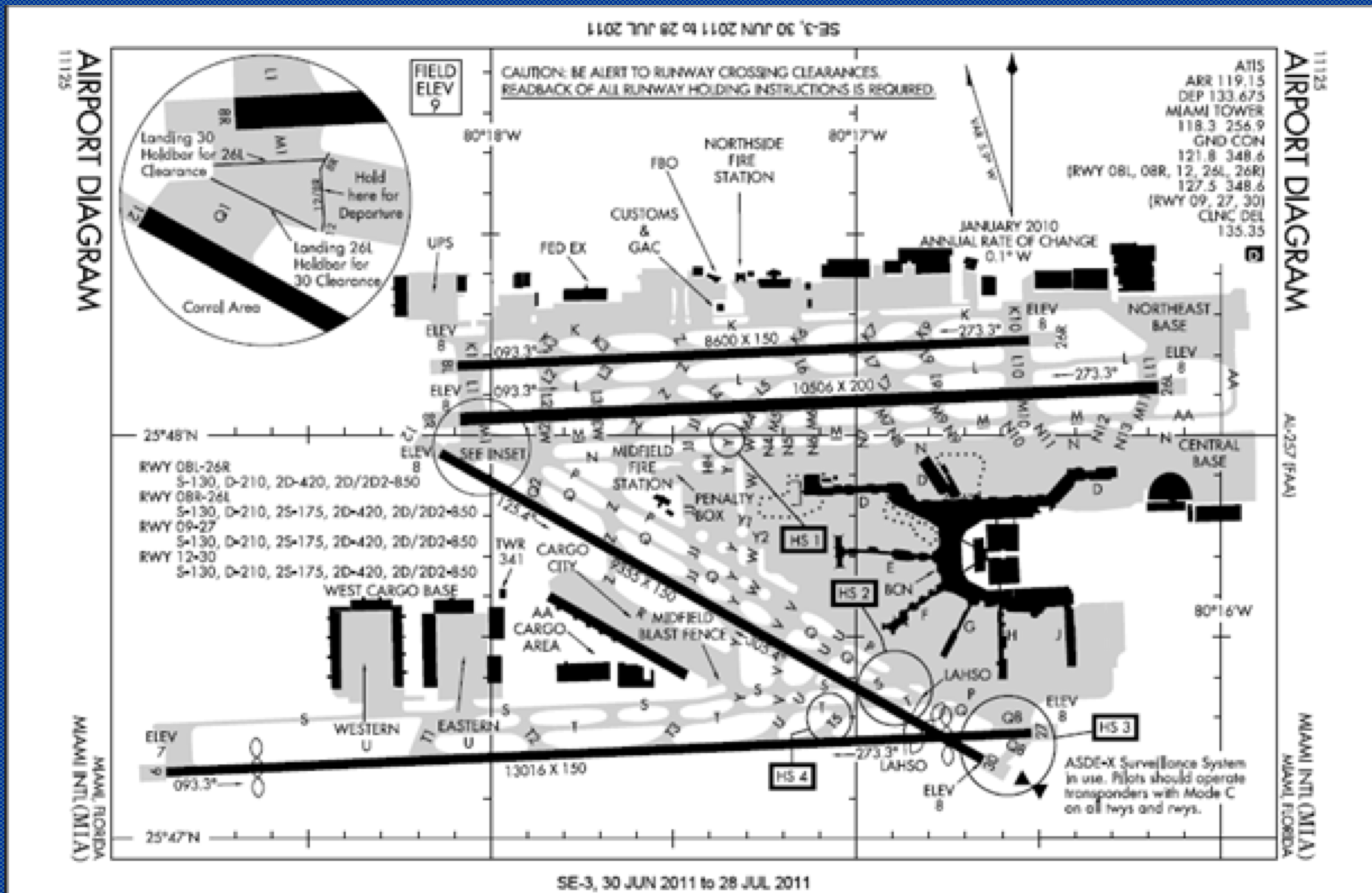
Land and Hold Short Operations (LAHSO) Can Be Conducted at More Than 200 Airports throughout the United States

- LAHSO Can Be Conducted in Way of Active Intersecting Runways and Taxiways.
- Runways Must Be Dry.
- Airlines/Pilots Can Reject LAHSO Requests.
- Test Track Data Supports LAHSO-Wet.
- Runways Are To Be Grooved, Have Good Texture and No Standing Water.
- LAHSO-Wet Enables Lost Airport Capacity To Be Recovered More Rapidly Following Periods of Rainfall. Costly Delays Could Be Reduced.

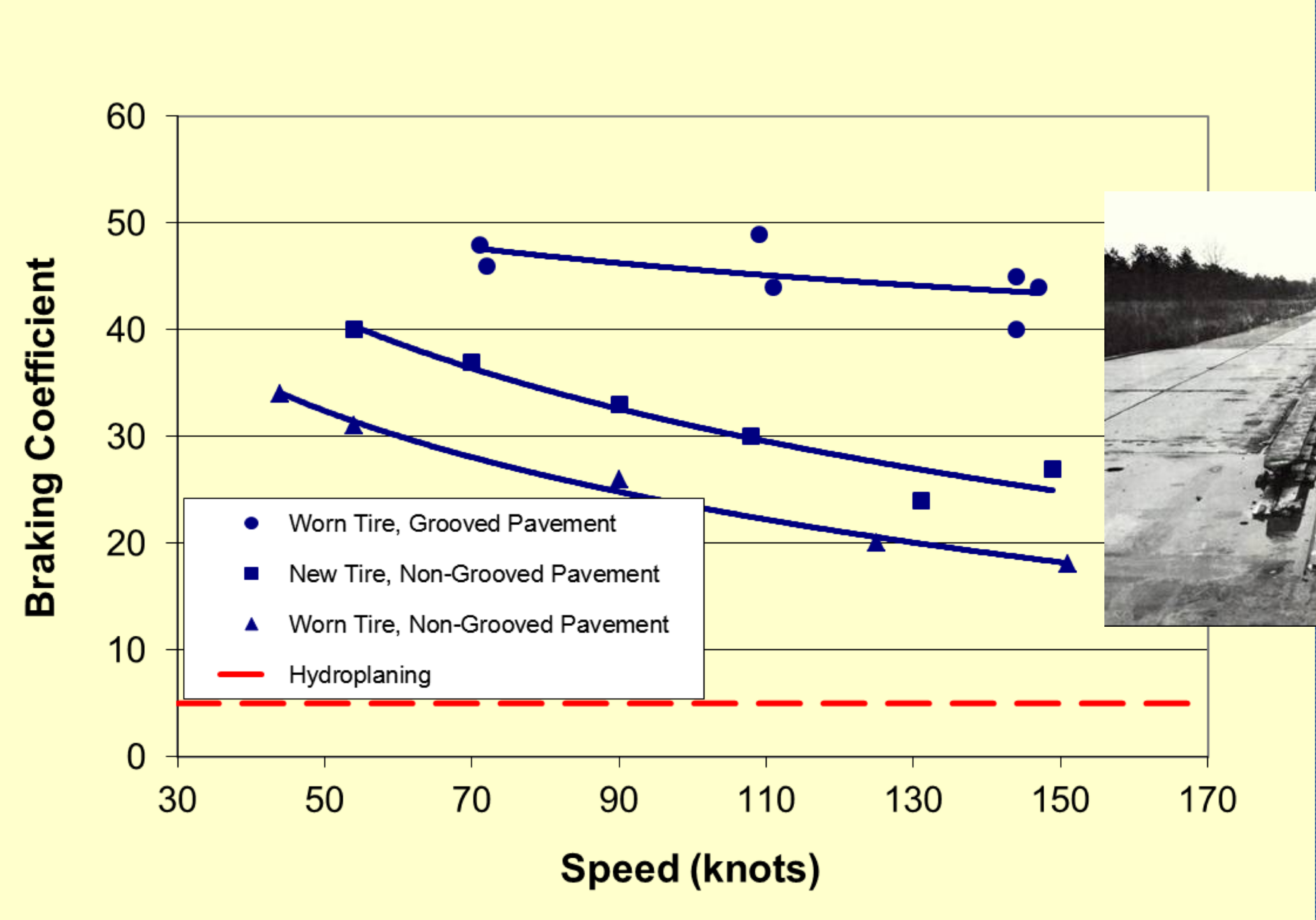
Two Successful Innovative Demonstrations of LAHSO-Wet Conducted in the 1980's

- Boston Logan International Airport (BOS)
- Significant Recovery of Lost Capacity Was Experienced at BOS.
- Miami International Airport (MIA)
- One Hour Delays, Every Day, Lasting Five Hours per Day Were Averted at MIA.

Miami International Airport (MIA)



Braking on a Wet Asphalt Pavement Upper Curve Supports LAHSO-Wet



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 Products of the Effort (Continued)

- Data Base Supports Landing and Hold Short Operations (LAHSO) on Grooved Runways in the Presence of Intersecting Runways or Taxiways under Wet Pavement Conditions Potentially Reducing Costly Delays.

FAA Full Scale Test Program
Braking/Hydroplaning

- DOT/FAA Technical Reports Available for Download from NAPTF Website

  www.airporttech.tc.faa.gov/naptf

- Located under "Downloads", "Safety"

Dynamic Test Track

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