WHILE NOT COMMON, INSTABILITY RUTTING (PUSHING/SHOVING) CAN OCCUR WITH AIRSIDE ASPHALT CONCRETE PAVEMENTS SUBJECTED TO HEAVY, SLOW MOVING WHEEL LOADINGS. THIS IS DEALT WITH THROUGH IMPROVED ASPHALT MATERIALS, DESIGNS AND CONSTRUCTION.
LIFE-CYCLE COST ANALYSIS AND VALUE ENGINEERING

FEEDBACK

INVENTORY

SAFE, SMOOTH, SURFACES
HAPPY CUSTOMERS

SYSTEMATIC PAVEMENT MAINTENANCE
MAINTENANCE MANAGEMENT SYSTEM

PAVEMENT MANAGEMENT SYSTEM
PERFORMANCE MONITORING

PAVEMENT DESIGN
NEW, OVERLAY, REHABILITATION

CONSTRUCT PAVEMENT
OR
OVERLAY PAVEMENT
OR
REHABILITATE PAVEMENT

PAVEMENT MATERIALS

PAVEMENT SERVICEABILITY

PERFORMANCE CRITERIA
PAVEMENT MODELS

INPUT INFORMATION

ASPHALT PAVEMENT LIFE

FLXIBLE PAVEMENT REHABILITATION IS REQUIRED WHEN SATISFACTORY FUNCTIONAL PERFORMANCE CANNOT BE MAINTAINED THROUGH SYSTEMATIC PRESERVATION STRATEGIES AND/OR THE PAVEMENT STRUCTURE IS NOT ADEQUATE

CAPTG, TORONTO SEPTEMBER 2005

ASSET MANAGEMENT

COMPREHENSIVE FRAMEWORK FOR MANAGING COST-EFFECTIVE RESOURCE ALLOCATION, DECISIONS PERFORMANCE EXPECTATIONS, INVENTORY AND PERFORMANCE INFORMATION, ANALYSIS AND EVALUATION, PROJECT SELECTION AND PROGRAM IMPLEMENTATION

HMA/PAVEMENT DESIGN

FLEXIBLE PAVEMENT REHABILITATION IS REQUIRED WHEN SATISFACTORY FUNCTIONAL PERFORMANCE CANNOT BE MAINTAINED THROUGH SYSTEMATIC PRESERVATION STRATEGIES AND/OR THE PAVEMENT STRUCTURE IS NOT ADEQUATE

SAFE, SMOOTH, SURFACES
HAPPY CUSTOMERS

SYSTEMATIC PAVEMENT MAINTENANCE
MAINTENANCE MANAGEMENT SYSTEM

PAVEMENT MANAGEMENT SYSTEM
PERFORMANCE MONITORING

CONSTRUCT PAVEMENT
OR
OVERLAY PAVEMENT
OR
REHABILITATE PAVEMENT

PAVEMENT DESIGN
NEW, OVERLAY, REHABILITATION

PAVEMENT MATERIALS

PAVEMENT SERVICEABILITY

PERFORMANCE CRITERIA
PAVEMENT MODELS

INPUT INFORMATION
FLYING HIGH ... Aerial view of Toronto’s “international” airport northwest of the city near the Village of Malton soon after the first official flight arrived from Buffalo on Aug. 29, 1938.
GTAA 1998
NEW TAXIWAY AND RUNWAY ASPHALT PAVEMENTS UNDER CONSTRUCTION
GTAA AIRBUS 380 GATE UNDER CONSTRUCTION 2005
CRUSHED RECYCLED CONCRETE FROM OLD TERMINAL TO THE LEFT
AIRFIELD ASPHALT PAVEMENTS ARE SUBJECTED TO A WIDE RANGE OF AIRCRAFT LOADINGS

HEAVY DUTY HOT-MIX ASPHALT IS REQUIRED FOR AIRFIELD ASPHALT PAVEMENTS SUBJECTED TO HEAVY AIRCRAFT LOADINGS
AIRFIELD ASPHALT PAVEMENTS ARE SUBJECTED TO A WIDE RANGE OF AIRCRAFT LOADINGS

HEAVY DUTY HOT-MIX ASPHALT IS REQUIRED FOR AIRFIELD ASPHALT PAVEMENTS SUBJECTED TO HEAVY AIRCRAFT LOADINGS
AIRFIELD ASPHALT PAVEMENTS ARE SUBJECT TO A WIDE RANGE OF AIRCRAFT LOADINGS

HEAVY DUTY HOT-MIX ASPHALT IS REQUIRED FOR AIRFIELD ASPHALT PAVEMENTS SUBJECT TO HEAVY AIRCRAFT LOADINGS
AIRFIELD ASPHALT PAVEMENTS ARE SUBJECTED TO A WIDE RANGE OF AIRCRAFT LOADINGS

THE ACTUAL LOADING OF CARGO IS ALSO IMPORTANT FOR HEAVY AIRCRAFT PARKED PERFORMANCE ON ASPHALT PAVEMENTS
CANADIAN AIRFIELD ASPHALT PAVEMENTS ARE SUBJECTED TO A WIDE RANGE OF CLIMATIC CONDITIONS
AIRFIELD ASPHALT PAVEMENTS MUST BE ABLE TO RESIST SHOVING, RUTTING AND JET BLAST
AIRFIELD ASPHALT PAVEMENT MUST BE DURABLE UNDER SEVERE OPERATING CONDITIONS OF LOADINGS, MAINTENANCE AND WEATHER

NEW ASPHALT PAVEMENT OVERLAY, BEIJING AIRPORT
NOTE NEW TERMINAL BUILDING UNDER CONSTRUCTION FOR 2008 OLYMPICS

FAIRLY OLD ASPHALT PAVEMENT OVERLAY, HAMILTON
NOTE THAT THE DETERIORATION OF THE SHOULDER (NO LOADINGS) IS MORE SEVERE THAN FOR THE CENTRAL SECTION (KEEL) OF THE RUNWAY
ASPHALT PAVEMENT PERFORMANCE REQUIREMENTS FOR AIRFIELD DENSE GRADED HOT-MIX ASPHALT

- WORKABLE DURING PLACEMENT AND COMPACTION
- CONTRIBUTE TO STRENGTH OF PAVEMENT STRUCTURE
- RESIST PERMANENT DEFORMATION (RUTTING)
- RESIST FATIGUE CRACKING
- RESIST THERMAL CRACKING
- RESIST THE EFFECTS OF AIR AND WATER (DURABILITY)
- IMPERMEABLE TO PROTECT PAVEMENT STRUCTURE FROM WATER
- EASILY AND COST-EFFECTIVELY MAINTAINED

PLUS FOR SURFACE COURSE

1. ADEQUATE FRICTIONAL PROPERTIES
2. ACCEPTABLE SMOOTHNESS
3. RESISTANCE TO ANTI-ICING AND DEICING CHEMICALS, ICE AND SNOW CONTROL, JET BLAST, AND AVIATION FUEL AND HYDRAULIC OIL SPILLS
4. RESISTANCE TO FOD POTENTIAL
AIRFIELD ASPHALT AND CONCRETE PAVEMENT DESIGNS REQUIRE INPUT INFORMATION ON DESIGN AIRCRAFT LOADING(S), SUBGRADE CONDITIONS, DRAINAGE AND CLIMATE (ENVIRONMENT)

PLATE LOADING TESTS WERE COMMONLY USED IN THE PAST FOR SUBGRADE AND BASE SUPPORT CONDITION DETERMINATION

THE HWD IS NOW COMMONLY USED TO DETERMINE THE SUBGRADE AND BASE SUPPORT CONDITION AND MR OF THE PAVEMENT COMPONENTS
A LIFE-CYCLE COST ANALYSIS, INCLUDING VALUE ENGINEERING, IS AN IMPORTANT COMPONENT OF AIRFIELD PAVEMENT DESIGNS

LIFE-CYCLE COST ANALYSIS SUMMARY

• ECONOMIC ASSESSMENT OF COMPETING, TECHNICALLY SUITABLE SYSTEMS OVER DESIGN LIFE
• COST COMPONENTS
  – INITIAL COSTS (CAPITAL COST)
  – MAINTENANCE COSTS
  – REHABILITATION COSTS
  – RESIDUAL/SALVAGE VALUE
  – USER COSTS (TRAFFIC DELAYS FOR INSTANCE)
• PRESENT-WORTH METHOD
  – DISCOUNT RATE
  – ANALYSIS PERIOD
• DETERMINISTIC AND PROBABILISTIC METHODS
  – JEGEL IS USING DETERMINISTIC METHODS BASED ON FHWA AND CRYSTAL BALL SOFTWARE
VALUE ENGINEERING IS A PROCESS CONSISTING OF THE SYSTEMATIC APPLICATION OF ANALYTICAL, CREATIVE AND EVALUATION TECHNIQUES ON A MULTI-DISCIPLINED BASIS TO ACHIEVE THE DESIRED FUNCTIONS FOR A DESIGN OR PROCESS WHILE MAXIMIZING VALUE AND MAINTAINING OR IMPROVING REQUIRED FUNCTIONS.

JEGEL

BOGOTA EL DORADO INTERNATIONAL AIRPORT EXISTING RUNWAY 1994
CONSTRUCTION OF THE NEW RUNWAY REQUIRED DIVERSION OF THE BOGOTÁ RIVER
THIS DIVERSION REQUIRED A DETAILED ANALYSIS OF THE MOST APPROPRIATED TYPE
RIGID OR FLEXIBLE – TO DEAL WITH POTENTIAL SETTLEMENTS
VALUE

VALIDATE THE INFORMATION AS IT IS ASSEMBLED

ALTERNATIVES - MAKE A LIST OF ALL THE POSSIBILITIES

LOOK CLOSELY AT EACH IDEA - ANALYZE AND EVALUATE POSSIBILITIES

USE SUITABLE ALTERNATIVES - DEVELOP INTO SOUND RECOMMENDATIONS

ENHANCE UNDERSTANDING - PRESENT RECOMMENDATIONS AND ASSIST IN CONCEPTUAL UNDERSTANDING
ASPHALT PAVEMENT LIFE

INPUT INFORMATION

PERFORMANCE CRITERIA

PAVEMENT MODELS

PAVEMENT SERVICEABILITY

PAVEMENT MATERIALS

PAVEMENT DESIGN

NEW, OVERLAY, REHABILITATION

CONSTRUCT PAVEMENT

OR

OVERLAY PAVEMENT

OR

REHABILITATE PAVEMENT

SYSTEMATIC PAVEMENT

MAINTENANCE

MAINTENANCE MANAGEMENT SYSTEM

PAVEMENT MANAGEMENT SYSTEM

PERFORMANCE MONITORING

SAFE, SMOOTH, SURFACES

HAPPY CUSTOMERS

FLEXIBLE PAVEMENT REHABILITATION IS REQUIRED WHEN SATISFACTORY FUNCTIONAL PERFORMANCE CANNOT BE MAINTAINED THROUGH SYSTEMATIC PRESERVATION STRATEGIES AND/OR THE PAVEMENT STRUCTURE IS NOT ADEQUATE

LIFE-CYCLE COST ANALYSIS AND VALUE ENGINEERING

ASSET MANAGEMENT

COMPREHENSIVE FRAMEWORK FOR MANAGING COST-EFFECTIVE RESOURCE ALLOCATION, DECISIONS PERFORMANCE EXPECTATIONS, INVENTORY AND PERFORMANCE INFORMATION, ANALYSIS AND EVALUATION, PROJECT SELECTION AND PROGRAM IMPLEMENTATION

FEEDBACK

INVENTORY

SAFE, SMOOTH, SURFACES

HAPPY CUSTOMERS

CAPTG, TORONTO

SEPTEMBER 2005

HMA/PAVEMENT DESIGN
- USE OF PAVEMENT CONDITION INDEX
- PAVEMENT CONDITION PREDICTION MODELLING
- ANALYSIS OF ROUTINE AND MAJOR MAINTENANCE NEEDS
- WORK PLAN BASED ON AVAILABLE BUDGET OR MAINTAINING REQUIRED PAVEMENT CONDITION LEVEL
- REPORTING LINKED TO GEOGRAPHIC INFORMATION SYSTEM

Micro PAVER GIS REPORT DISPLAY

JEGEL

CAPTQ, TORONTO
HMA/PAVEMENT DESIGN

AIRPORT PAVEMENT MANAGEMENT SYSTEMS

Micro PAVER 5.2
DECISION TREE FOR FLEXIBLE PAVEMENT MAINTENANCE AND REHABILITATION

PREVENTIVE MAINTENANCE TREATMENT

SURFACE WEAR SEVERITY

ENVIRO CRACKING EXTENT

FATIGUE CRACKING EXTENT

RUTTING SEVERITY

REHABILITATION TREATMENT

CRACK SEALING

SURFACE TREATMENT

CRACK SEALING +40 mm OVERLAY OR HIR

CRACK SEALING

MILL/FILL 40 mm OR HIR

MILL/FILL 50 mm OR HIR

MILL/FILL 40 mm OR HIR

MILL/FILL 50 mm OR HIR

MILL/FILL 50 mm OR HIR

MILL/FILL 50 mm OR HIR

MILL/FILL 75 mm OR HIR (?) OR CIR AND OVERLAY (DESIGN)

MILL FILL 50 mm OR HIR

MILL FILL 75 mm OR HIR

MILL 50 mm OVERLAY 75 mm OR HIR (?)

MILL 50 mm OVERLAY 100 mm OR CIR AND OVERLAY (DESIGN)

MILL 75 mm OVERLAY 125 mm OR CIR AND OVERLAY (DESIGN)

MILL 100 mm OVERLAY 125 mm OR CIR AND OVERLAY (DESIGN)

MILL 100 mm OVERLAY 100 mm OR CIR AND OVERLAY (DESIGN)

MILL 100 mm OVERLAY 125 mm OR CIR AND OVERLAY (DESIGN)

TOTAL RECONSTRUCTION OR FDR AND OVERLAY (DESIGN)

ADAPTED FROM FP²

MODERATE

LOW

MODERATE

MODERATE

HIGH

LOW

MILL/FILL 40 mm OR HIR

MILL/FILL 50 mm OR HIR

MILL/FILL 75 mm OR HIR

MILL 50 mm OVERLAY 75 mm OR HIR (?)

MILL 50 mm OVERLAY 100 mm OR CIR AND OVERLAY (DESIGN)

MILL 75 mm OVERLAY 125 mm OR CIR AND OVERLAY (DESIGN)

MILL 100 mm OVERLAY 125 mm OR CIR AND OVERLAY (DESIGN)

MILL 100 mm OVERLAY 100 mm OR CIR AND OVERLAY (DESIGN)

TOTAL RECONSTRUCTION OR FDR AND OVERLAY (DESIGN)

ADAPTED FROM FP²
FOAMED ASPHALT STABILIZATION IS A GROWING REHABILITATION TECHNIQUE FOR AIRPORT ASPHALT PAVEMENTS

RESILIENT MODULUS VERSUS TEMPERATURE RELATIONSHIP FOR HOT-MIX ASPHALT AND FOAMED ASPHALT, TYPICAL CORES, GEORGIA
AIRPORT ASPHALT AND CONCRETE PAVEMENT REHABILITATION CASE STUDY

GTAA 05/23 RUNWAY REHABILITATION EVALUATION AND SELECTION

THE GTAA USES A MicroPAVER BASED PAVEMENT MANAGEMENT SYSTEM
THIS INCLUDES HWD LOAD RATING AND LASER PROFILOMETER SMOOTHNESS MONITORING

JEGEL
Runway 05/23 prior to rehabilitation in 2004 and 2005.
METHODOLOGY

- ENGINEERING SITE VISIT
- REVIEW OF PAVEMENT HISTORY
- PAVEMENT CONDITION SURVEY – MICROPAVING, PAVEMENT DISTRESSES, PCI
- FWD LOAD/DEFLECTION TESTING – DEFLECTION, ELASTIC MODULUS, LOAD TRANSFER, PRESENCE OF VOIDS
- GEOTECHNICAL INVESTIGATION – PAVEMENT CORING AND BOREHOLE/PROBEHOLE INVESTIGATION
- LABORATORY TESTING
- SYNTHESIS OF FINDINGS
- REHABILITATION METHODS SELECTION (PAVEMENT DESIGN, VALUE ENGINEERING AND LIFE CYCLE COST ANALYSIS)
EVALUATION OF PAVEMENT CONDITION

EVALUATION OF ASPHALT PAVEMENT SECTION CRACKING

EVALUATION OF CONCRETE PAVEMENT SECTION KEYWAY
PAVEMENT DESIGN ALTERNATIVES
KEEL SECTION

• CONCRETE PAVEMENT RESTORATION (CPR) AND THIN HMA OVERLAY
• THICK OVERLAY OVER EXISTING CONCRETE PAVEMENT
• CONCRETE PAVEMENT RUBBLIZATION AND THICK HMA OVERLAY
• CONCRETE PAVEMENT RECONSTRUCTION
### Life-Cycle Cost Analysis

**ALTERNATIVE** | **INITIAL CONSTRUCTION** | **MAJOR MAINTENANCE** | **RESIDUAL VALUE** | **SALVAGE VALUE** | **30-YEAR LCC, PW**
--- | --- | --- | --- | --- | ---
CPR AND THIN HMA OVERLAY | $2,712,900 | $2,181,312 | - $500,401 | - $41,822 | $4,351,989
THICK HMA OVERLAY | $2,660,875 | $1,253,685 | - $380,928 | - $41,020 | $3,492,612
RUBBLIZATION AND THICK HMA OVERLAY | $3,313,500 | $1,125,026 | - $380,774 | - $51,112 | $4,006,641
CONCRETE PAVEMENT RECONSTRUCTION | 3,155,400 | | - $48,643 | | $3,106,757

SELECTED FOR LOGISTICAL (OPERATIONS) REASONS.
RUNWAY RETURNED TO FULL AND SMOOTH SERVICE
NEW ASPHALT PAVEMENT CONSTRUCTION METHODS

PLACING LOWER COURSE HIGH PERFORMANCE HOT-MIX ASPHALT OVER PREPARED PORTLAND CEMENT CONCRETE SLABS WITH A POLYMER MODIFIED EMULSION TACK COAT, GTAA
NEW PAVING EQUIPMENT DEVELOPMENT

ASPHALT PAVERS WITH THE ABILITY TO APPLY EMULSIFIED ASPHALT TACK COAT
OR PREFERABLY HOT ASPHALT CEMENT TACK COAT
WATER TRAPPED UNDER THE CRACK SEALANT, RUNWAY 08-26, CFB GOOSE BAY
SAMPLE WITH ROUTED RESERVOIR FILLED WITH CRACK SEALANT AND THEN CONDITIONED IN WATER FOR 24 HOURS READY FOR TESTING IN THE APA
IMPROVED ASPHALT LIFT INTERFACE PERFORMANCE

APA ASPHALT CONCRETE LAYERS INTERFACE SHEAR RESISTANCE AND ‘LARGE SLAB’ RESISTANCE TO RUTTING TESTS CONFIGURATION
(70 mm WIDE SOLID RUBBER WHEEL, SLAB 300 mm x 300 mm)
RESISTANCE OF HOT-MIX ASPHALT TO ANTI-ICING AND DEICING CHEMICALS

UREA DAMAGE TO HMA WITH A MOISTURE SUSCEPTIBILITY PROBLEM, DND GREENWOOD
PERMANENT DEFORMATION (APA) OF HOT-MIX ASPHALT IN DIFFERENT ANTI-ICING AND DEICING CHEMICALS
NEW ASPHALT PAVEMENT CONSTRUCTION METHODS

FIELD TESTING OF ASPHALT CONCRETE PAVEMENT WITH IMPACT-ECHO EQUIPMENT TO DETERMINE CRACKING AND INTERFACE CONDITIONS
JEGEL IN ASSOCIATION WITH McMASTER UNIVERSITY
NEW ASPHALT PAVEMENT TESTING METHODS

HYDRATED LIME SURFACE TREATMENT TO REDUCE ASPHALT PAVEMENT TEMPERATURE (BLACK BODY ABSORPTION)
NEW ASPHALT PAVEMENT DISTRESS TYPE

TOP-DOWN CRACKING OF ASPHALT CONCRETE IS NOT GENERALLY CONSIDERED IN CURRENT ASPHALT DESIGN PROCEDURES. IT IS NOW BEING CONSIDERED FOR LONG-LIFE ASPHALT PAVEMENTS. TOP-DOWN CRACKING HAS NOT BEEN STUDIED FOR AIRFIELDS.

TRADITIONAL FATIGUE CRACKING

ASPHALT CONCRETE

TOP-DOWN CRACKING (TDC)

ASPHALT CONCRETE

CRACKING OF RELATIVELY NEW ASPHALT PAVEMENT
TRANSVERSE THERMAL CRACK WITH TOP DOWN CRACKING (TDC) IN WHEELPATH

HOTHOT, INNER MONGOLIA

JEGEL
NEW ASPHALT PAVEMENT DESIGN CONCEPTS

STATE-OF-PRACTICE

ACTUAL CURRENT PRACTICE??

STATE-OF-THE-ART
AASHTO’s 2002 MECHANISTIC-EMPIRICAL DESIGN METHOD IS A HIERARCHICAL OR MULTI-LEVEL PROCEDURE BASED ON DESIGN DATA REQUIREMENTS REFLECTING ROADWAY CLASSIFICATION. A SIGNIFICANT CHANGE FROM PREVIOUS METHODS IS THE USE OF VEHICLE AXLE LOAD SPECTRA (AXLE LOAD DISTRIBUTION) RATHER THAN EQUIVALENT SINGLE AXLE LOADS (ESALs) TO EVALUATE PAVEMENT LOADING OVER SERVICE LIFE. AASHTO’s 2002 GUIDE ALSO INCORPORATES THE LATEST TECHNOLOGIES IN MATERIALS CHARACTERIZATION AND IN THE USE OF CLIMATE DATA THROUGH THE APPLICATION OF AN ENHANCED INTEGRATED CLIMATE MODEL (ICM). BY USING THE ICM, VARIATIONS IN MATERIAL AND SUBGRADE PROPERTIES SPECIFIC TO LOCAL TEMPERATURES, HUMIDITY AND PRECIPITATION ARE ALL FACTORED INTO THE DESIGN PROCESS.
AASHTO 2002 FOR ASPHALT PAVEMENT DESIGN
GENERAL DESIGN APPROACH

ENVIRONMENT MATERIALS TRAFFIC

PROCESS RAW INPUT FOR DISTRESS MODELING

ASSEMBLE INPUT AND TRIAL DESIGN INFORMATION FOR EACH DISTRESS MODEL

STRESS DEFLECTION ANALYSIS
CALCULATE STRESS \( \cup \) CALCULATE DAMAGE \( \cup \) PREDICT AMOUNT OF DISTRESS

PREDICT SMOOTHNESS OVER TIME

CHECK PREDICTED PERFORMANCE AGAINST DESIGN STANDARDS

[ REVISE DESIGN AS NECESSARY ]
TO SATISFY DESIGN STANDARD

DESIGN COMPLETE
THE TECHNICAL ASSISTANCE OF ALAIN DUCLOS IS GRATEFULLY ACKNOWLEDGED

MICROSURFACING OF THE ASPHALT RUNWAY AT THE TORONTO ISLAND AIRPORT
YOU WILL SEE THE CITY AND ISLAND AIRPORT LIGHTS MONDAY!