

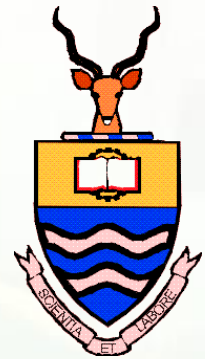


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SLIPPERY ASPHALT RUNWAYS AFTER REJUVENATION

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BOEING 757- 200 ON WET RUNWAY



**BITUMEN IN WHEEL TRACK
AFTER SKIDDING ON
REJUVENATOR**



INTRODUCTION

- Several accidents/incidents have occurred recently due to slippery runways after rejuvenation.
- Normal ageing of asphalt (flexible) runways:
 - asphalt becomes oxidised and brittle,
 - normal to overlay / replace every 10-20+ years,
 - the overlay has a significant cost.
- Some airports have attempted to delay runway overlay a few years by rejuvenating existing asphalt:
 - spray on a light coating of bitumen or coal tar, or apply a proprietary product;
 - this treatment has been used on some roads successfully.



OVERRUN ACCIDENTS OCCUR FOR MANY REASONS – NOT JUST REJUVENATION



INCIDENTS AND ACCIDENTS WHERE REJUVENATION WAS A CAUSE

- Very few occurrences in old accident databases.
- Chile accident 1991:
 - BAe146 overran wet runway and went into sea,
 - runway recently fog-sealed.
- Norway incident 1995:
 - hotmix asphalt runway,
 - bitumen emulsion rejuvenator applied heavily,
 - aircraft reported slippery conditions,
 - friction testing couldn't detect any problem.
- Recent South African accident and Australian incident.



SOUTH AFRICAN ACCIDENT

- Dec 2009 at George.
- Old runway asphalt was rejuvenated,
 - runway had poor shape, runway not grooved.
- During the first rains, Embraer 135 overran runway.
- Rejuvenation had destroyed microtexture, filled the macrotexture.



AUSTRALIAN INCIDENT

- Nov 2010 at Hobart.
- Old runway asphalt rejuvenated,
 - rubber build-up,
patches ungrooved.
- Reports of slippery conditions, then Boeing 737-800 overran,
- Rejuvenation destroyed microtexture, filled macrotexture, part-filled grooves.



BACKGROUND TO WET WEATHER FRICTION

- Aircraft braking action results from friction force between tyres and runway surface.
- Wet runways have lower friction coefficients,
 - friction can be affected by rejuvenation which acts as a dry contaminate.
- THERE ARE 3 TYPES OF AQUAPLANING
 - **Dynamic** – caused by hydrodynamic force lifting the tyre off the runway, resulting in the aircraft 'water-skiing'. Occurs with standing water (3+ mm deep and at speed).



BACKGROUND /2

- Dynamic
- **Viscous** – caused by a thin film of water on the runway that acts as a lubricant and reduces the runway friction coefficient.
 - can occur at low and high speeds.
- **Reverted-rubber** - wheel 'locks up' on landing, steam is generated by the friction on the wet surface, and heats the tyre surface which reverts back to its unvulcanised (i.e. uncured, sticky and deformable) state.
 - akin to viscous skidding.



TYRE DAMAGE DUE TO REVERTED RUBBER SKIDDING AT GEORGE



REQUIREMENTS FOR GOOD WET WEATHER FRICTION

- Four legs of good wet friction are:
 - macrotexture,
 - microtexture,
 - geometry and,
 - drainage
- ICAO Annex 14
 - *International Civil Aviation Organisation.*
 - has requirements for surface texture, minimum crossfall slope for drainage, and good shape/ minimum ruts to avoid water ponding.



GROOVING FOR ADDED MACROTEXTURE - in a tropical storm at Bangkok



TECHNOLOGY OF REJUVENATION

- Hot-mix asphalt (HMA) ages and becomes brittle as a consequence of bitumen oxidation,
 - usually replaced, but cost cutting means a few airports have tried rejuvenation.
- Two methods of rejuvenation:
 - addition of solvents/oils to restoring flexibility,
 - surface treatments to protect and rebind; using bitumen emulsion, fog sprays, and/or proprietary rejuvenators including coal tar.
- Rejuvenation used on roads, aprons, taxiways,
 - not normally used on asphalt runways.



TECHNOLOGY OF REVERTED RUBBER AQUAPLANING

- Occurred on smooth, wet or puddled runways:
 - loss of braking down to 5-8 knots,
 - tyres had patch of sticky, soft rubber on tread (*reverted rubber*).
- Melted tyre rubber forms seal around edge of contact patch:
 - seals in high pressure super-heated steam under contact patch,
 - steam pressure lifts tyre away from the surface.
- Clean white streaks seen on asphalt surface:
 - contaminant cleaned off by high pressure super-heated steam.



REVERTED RUBBER AQUAPLANING ON REJUVENATOR

- Rejuvenator adds to the seal around the tyre contact patch:
 - bitumen close to softening point in normal service,
 - at wheel-spin up during landing, temperature of bitumen in the contact area rises,
 - either/or
 - bitumen melts and forms a slippery, surface where sliding can take place [bituplaning],
 - bitumen melts and improves seal around contact patch, trapping steam [reverted rubber skidding].



PROBLEMS WITH FRICTION MEASUREMENTS

- Difficulty in detecting rejuvenation / slippery runway.
- Experience is that continuously measuring friction equipment (CMFE):
 - **cannot be relied upon** to detect slippery runways for the reverted rubber skidding mode,
 - potential problem is apparent upon visual inspection by **highly experienced** airport engineers,
 - but not to casual or general inspection.
 - CMFE may show friction using self-wet as acceptable.



PROBLEMS WITH FRICTION MEASUREMENTS /2

- Surfaces with localised depressions, surface ruts, cracking, poor shape may exist
 - could result in water pooling in wet weather
- CMFE testing in self-wet mode does not pick these up
 - runway can have good CMFE results during testing with 1mm water depth, and still be slippery to aircraft when wet.
 - the full scale aircraft braking test at George detected the poor performing rejuvenation treatment, yet the CMFE measured friction was good.



CMFE FRICTION TESTING EQUIPMENT



REJUVENATOR EFFECT ON TEXTURE



TREATMENT OF SLIPPERY RUNWAYS AFTER REJUVENATION

- Assess runway defects:
 - macrotexture and microtexture,
 - CMFE not reliably detect reverted rubber skid potential,
 - geometry, shape and drainage are important.
- Treatments:
 - high pressure water blast OFF the rejuvenator, or
 - overlay runway with asphalt,
 - which also corrects ruts and shape and drainage,
 - or apply friction treatment (UTFC).



SLIPPERY WHEN WET
Flight Safety Australia, Sept-Oct 2000

**“ Managers of smaller
aerodromes should think
twice about calling in...
road sealing contractors
for aerodrome work. ”**



TEMPORARY MEASURES FOR CONTAMINATED RUNWAY

- Consider runway closure until repaired,
 - or limiting wet weather use.
- Issue urgent "Notice to Airmen" of slippery runway.
- Operational measures include:
 - limiting fuel carried (weight),
 - thrust reversers to be fully operational,
 - no "reduced thrust" operations,
 - no takeoff in heavy rain,
 - Captain to do landing.



CONCLUSIONS

- Excess rejuvenation is a contaminant,
 - like other contaminants, it should be removed.
- In the interim before removal:
 - operational restrictions must be urgently applied or the runway closed.
- Rejuvenation of hot-mix asphalt runways appears to be poor engineering practice;
 - best result is by overlaying or replacing hotmix asphalt when it is aged,
 - overlay also allows correction of ruts and depressions that could lead to dynamic aquaplaning.

