

HMA TESTING FEEDBACK

Prepared for the APT Steering Committee meeting
19 February 2008

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Presentation structure

- Background
- HMA testing
 - Standard mix
 - HVS
 - Laboratory
 - Rut resistant mixes
 - Planned structure
 - Mix design

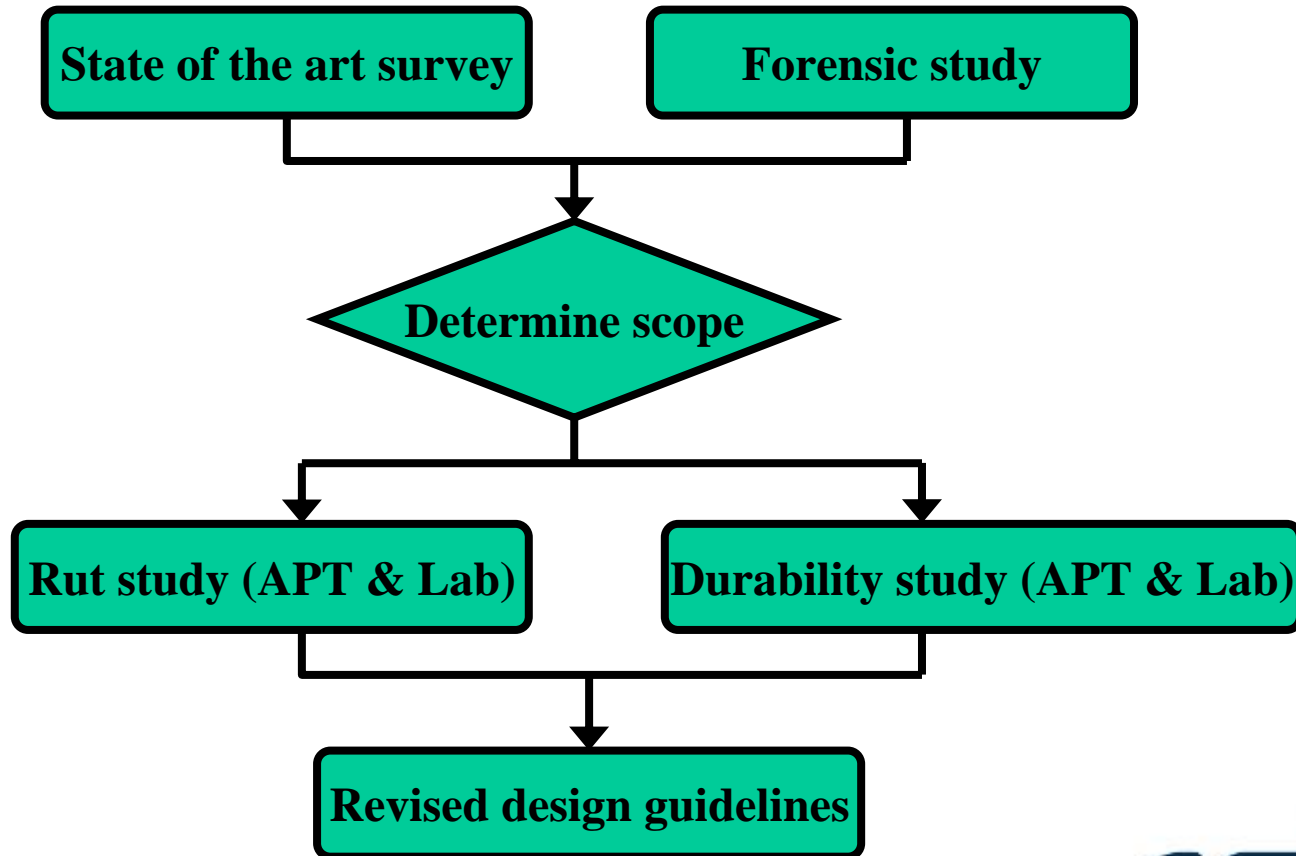


Background

- Problem statement
 - Issues around HMA performance
 - Increased rutting and premature fatigue failure
 - Improved laboratory evaluation of mixes
 - More realistic probabilistic approach towards HMA design
- Forensic study
- General progress
- Overall HMA project
 - Rut resistance
 - Durability
- Updated guidelines



Background: HVS research programme



Background: Forensic Study

- Mix designs to be better aligned to design environment
- More attention to be given to aggregate packing
- More rut resistant mixes for intersections
- Design protocols for SMA to be developed / refined



Background: Progress

- Phase 1: State of the art survey completed in 2005/6
- Phase 2: Forensic study completed in 2006/7
- Phase 3/1: Laboratory study completed
 - Due for comments
- Phase 3/2: APT study almost completed
 - 1 test remaining
 - Due for completion March 2008
- Phase 4: Evaluation of rut resistant HMA
 - Due to start end March 2008
 - 4 months of APT and laboratory evaluation
- Phases 5 to 7: Advanced evaluation
 - Planned after completion of Phase 4
 - Include durability and fatigue testing



HMA testing: Standard mix - HVS

- Objective to obtain base-line information on rut performance of standard HMA mix
- Series of 10 tests focusing on
 - Layer thickness
 - Temperature
 - Applied load condition (tyre load, inflation pressure, uni-/bi-directional, wander/channelised)
- **Outputs**
 - Effects of the various parameters
 - Guideline for comparative rut resistant testing



HMA testing: Standard mix - HVS

| Test Number | Loading Conditions (Dual tyres) | Channelised/wandering | Temperature | Speed | Single / dual tyres | Uni- / bi-directional | Layer thickness | Total Repetitions |
|-------------|---------------------------------|-----------------------|--------------|-------------------|---------------------|-----------------------|-----------------|-------------------|
| 441A4 | 1 x std case (40 kN, 620 kPa) | Channelised | 60°C | Constant 10 km/hr | Dual | Uni | 40 mm | 97 500 |
| 442A4 | 1 x std case (40 kN, 620 kPa) | Channelised | 40, 50, 60°C | Constant 10 km/hr | Dual | Uni | 40 mm | 56 903 |
| 443A4 | 1 x std case (40 kN, 620 kPa) | Channelised | 50, 55, 60°C | Constant 10 km/hr | Dual | Uni | 40 mm | 247 441 |
| 444A4 | 1 x std case (40 kN, 620 kPa) | Channelised | 50, 55, 60°C | Constant 10 km/hr | Dual | Uni | 25 mm | 289 886 |
| 445A4 | 1 x std case (40 kN, 620 kPa) | Channelised | 50, 55, 60°C | Constant 10 km/hr | Dual | Uni | 60 mm | 472 036 |
| 445A4A | 1 x std case (40 kN, 620 kPa) | Channelised | 60°C | Constant 10 km/hr | Dual | Uni | 60 mm | 163 291 |
| 446A4 | 1 x n-shape (60 kN, 800 kPa) | Channelised | 60°C | Constant 10 km/hr | Dual | Bi | 40 mm | 80 300 |
| 447A4 | 1 x n-shape (60 kN, 800 kPa) | Channelised | 60°C | Constant 10 km/hr | Dual | Uni | 40 mm | 75 337 |
| 448A4 | 1 x m-shape (60 kN, 420 kPa) | Channelised | 60°C | Constant 10 km/hr | Dual | Bi | 40 mm | 212 171 |
| 449A4 | 1 x n-shape (60 kN, 800 kPa) | Wandering | 60°C | Constant 10 km/hr | Dual | Bi | 40 mm | 306 888 |
| 450A4 | 1 x m-shape (60 kN, 420 kPa) | Wandering | 60°C | Constant 10 km/hr | Dual | Uni | 40 mm | |

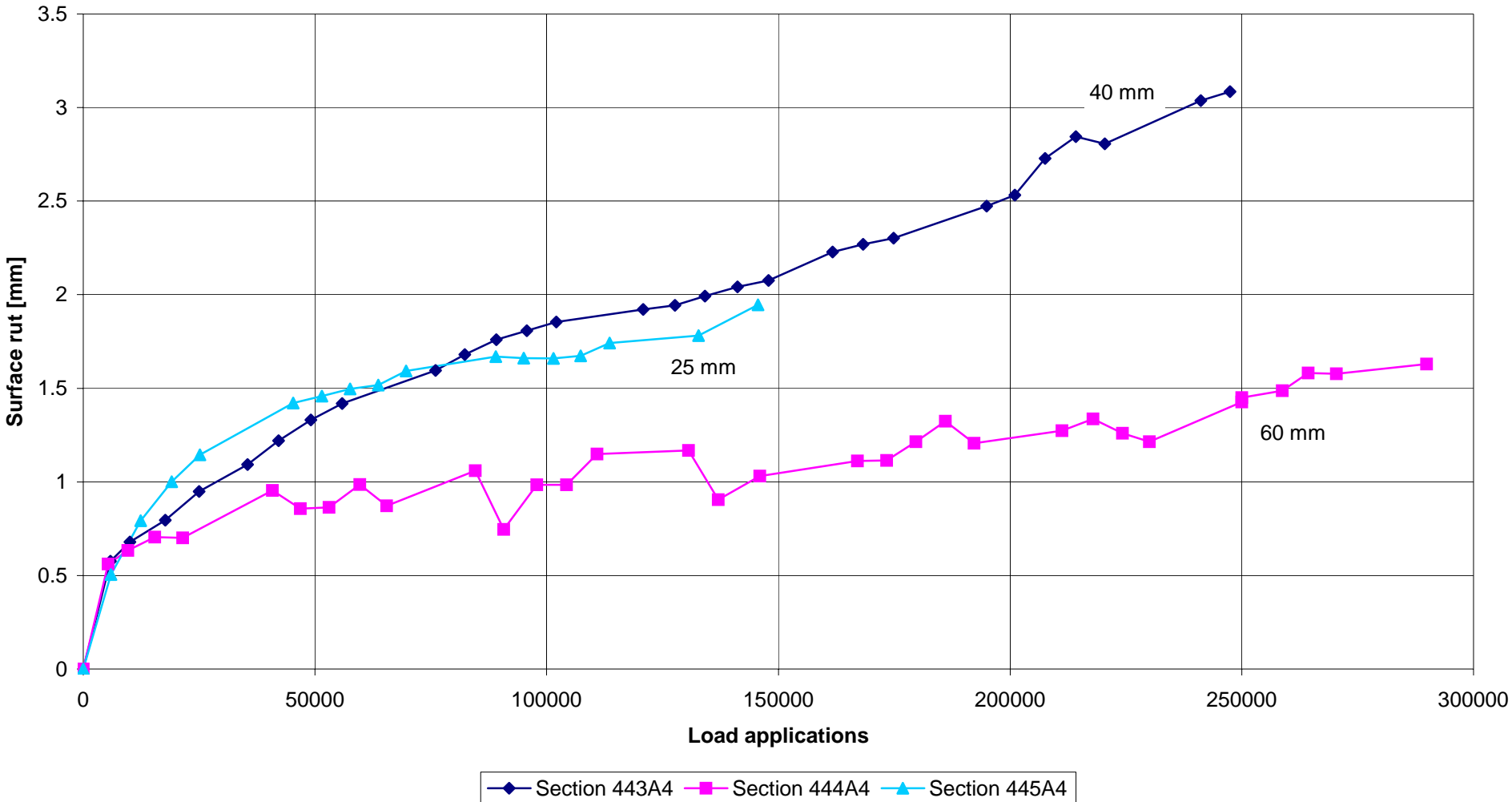
HMA testing: Standard mix - HVS

- Initial outputs
 - Layer thickness
 - Temperature
 - Tyre load / inflation pressure
 - Uni-/bi-directional
 - Wander/channelised



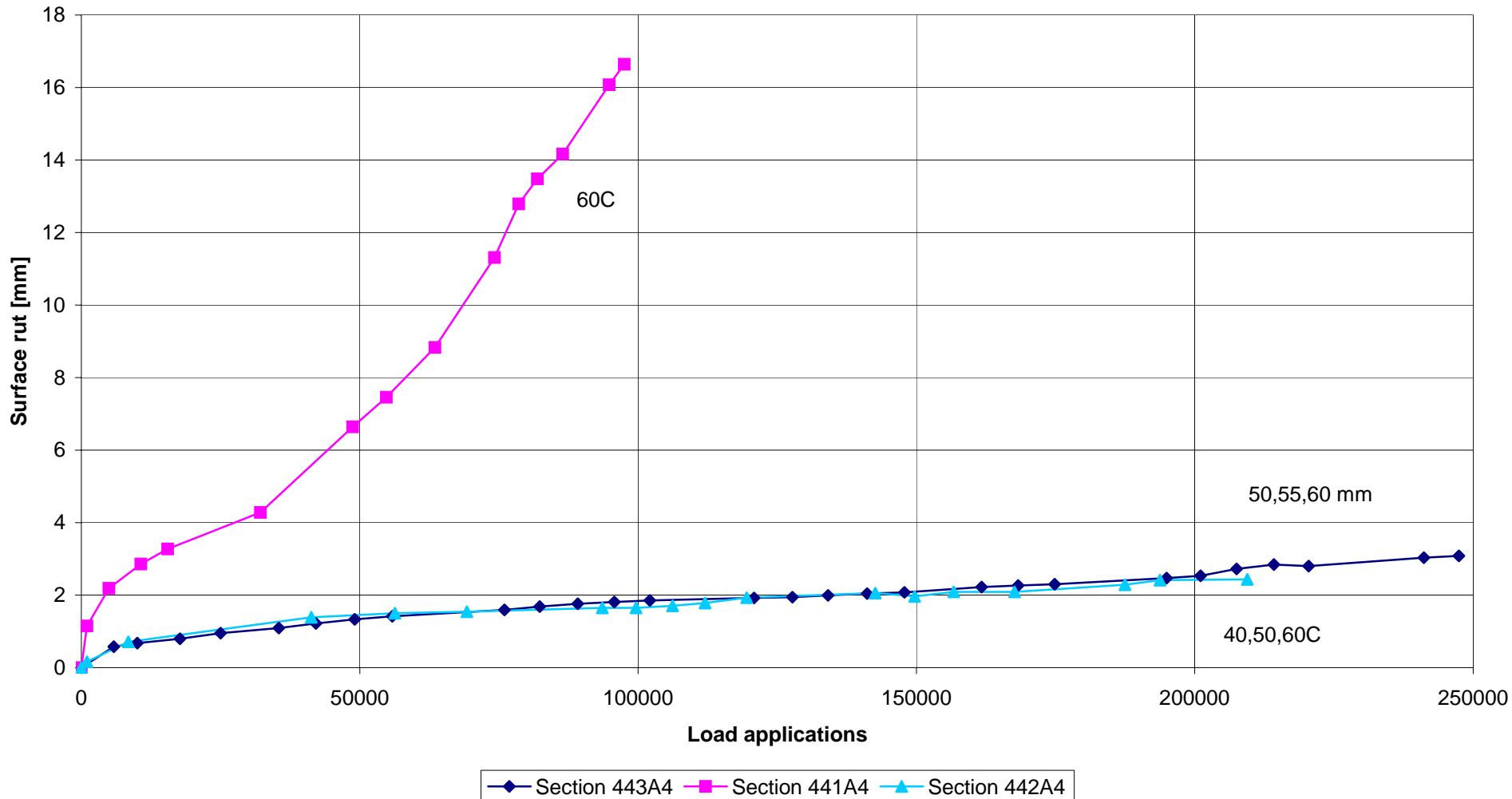
HMA testing: Standard mix – HVS – Layer thickness

Thickness effects
Caravan side - between tyres



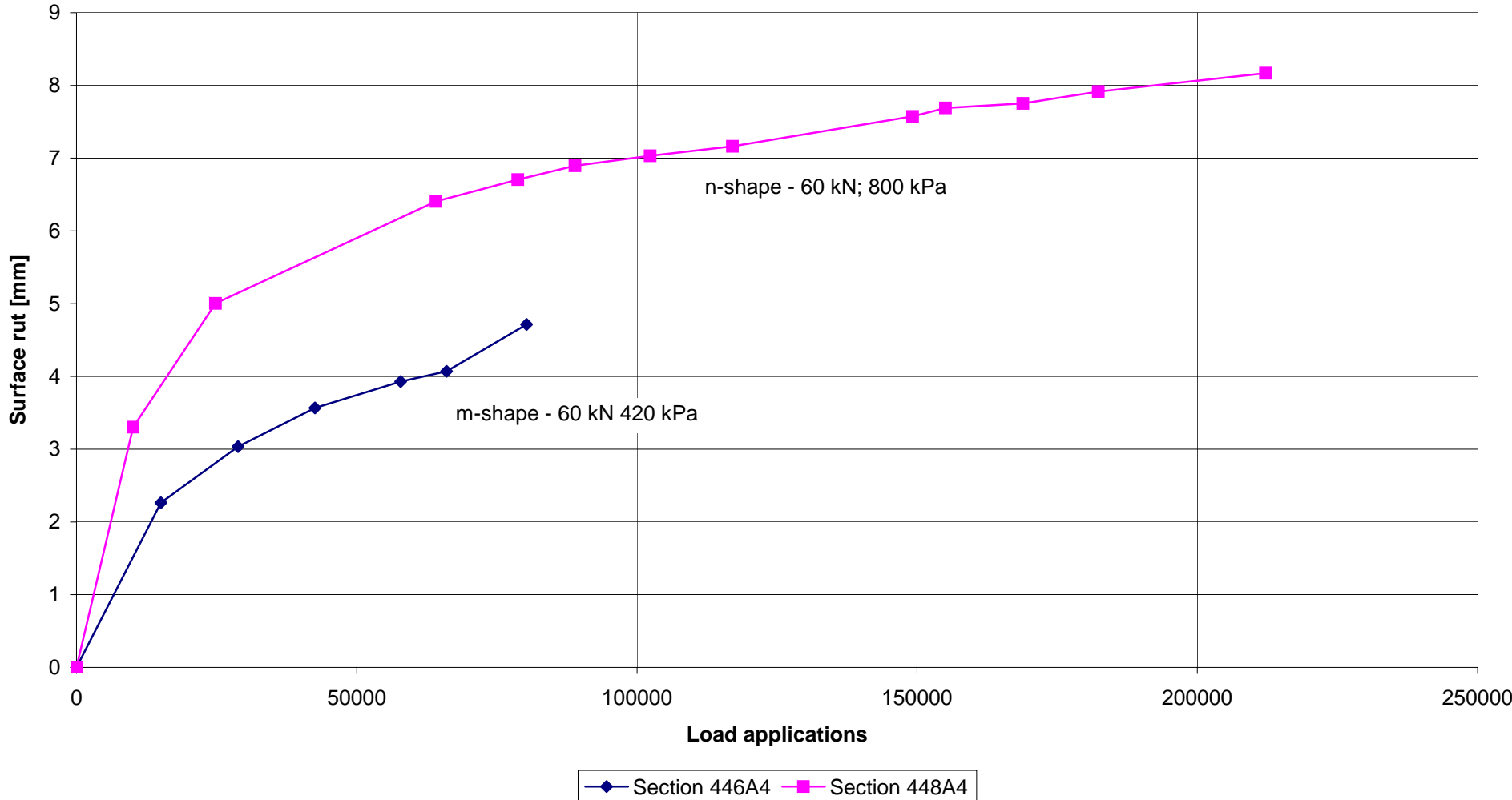
HMA testing: Standard mix – HVS – Temperature

Temperature effects
Caravan side - between tyres



HMA testing: Standard mix – HVS – Tyre load / inflation pressure

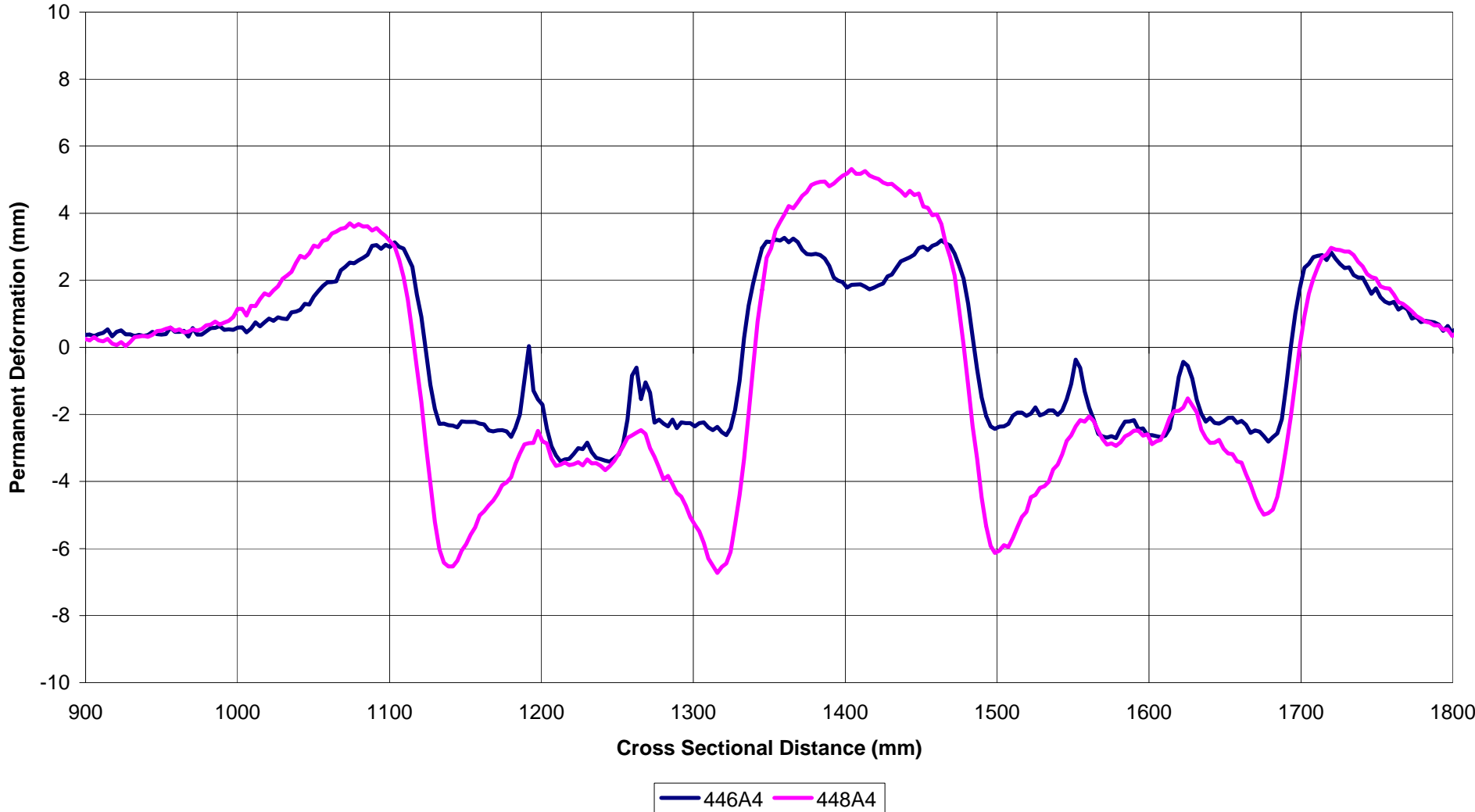
**Contact stress effects
Caravan side - between tyres**



HMA testing: Standard mix – HVS – Tyre load / inflation pressure

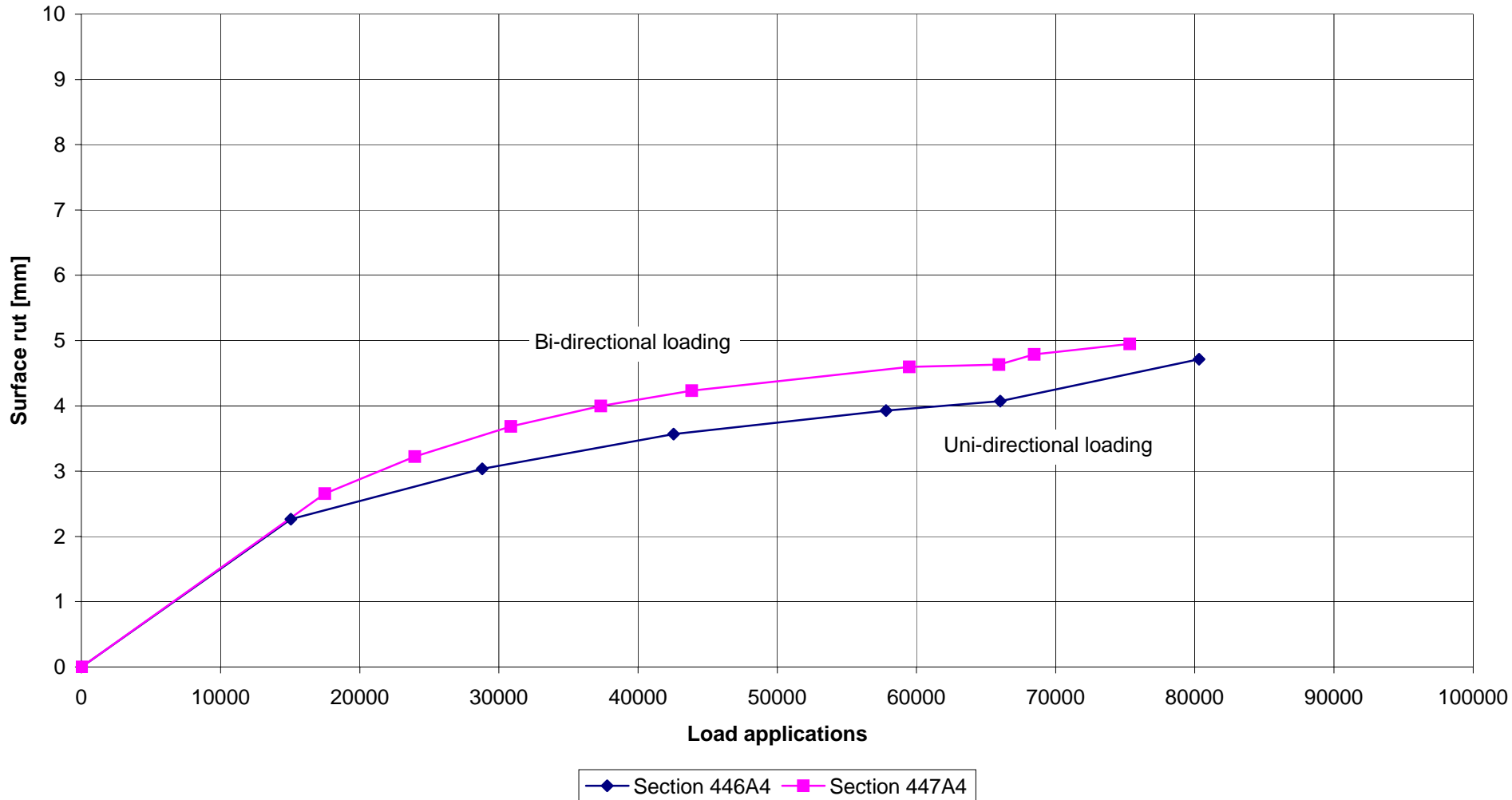
Section 446A4 "n" & 448A4 "M" Shape Average of 21 Measuring Points (60kN @ 800 / 420kPa)

Channelized and Bi-Directional



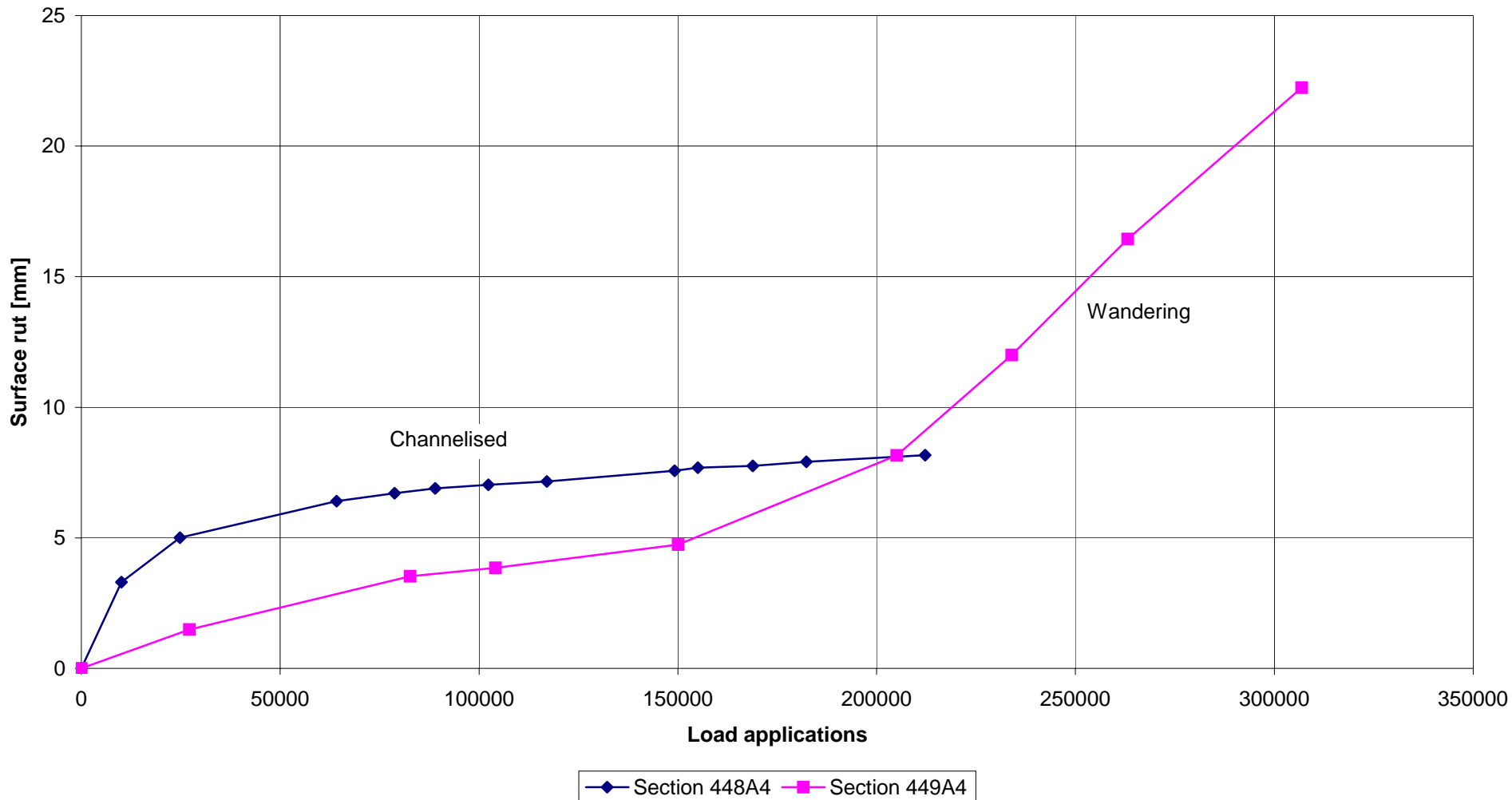
HMA testing: Standard mix – HVS – Uni/bi-directional

Uni- vs Bi-directional loading effects
Caravan side - between tyres



HMA testing: Standard mix – HVS – Wander / channelised

Wandering vs Channelised loading effects
Caravan side - between tyres



HMA testing: Standard mix – HVS – Wander / channelised – cross section photo



HMA testing: Standard mix – APT

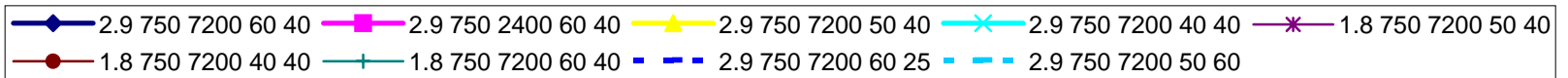
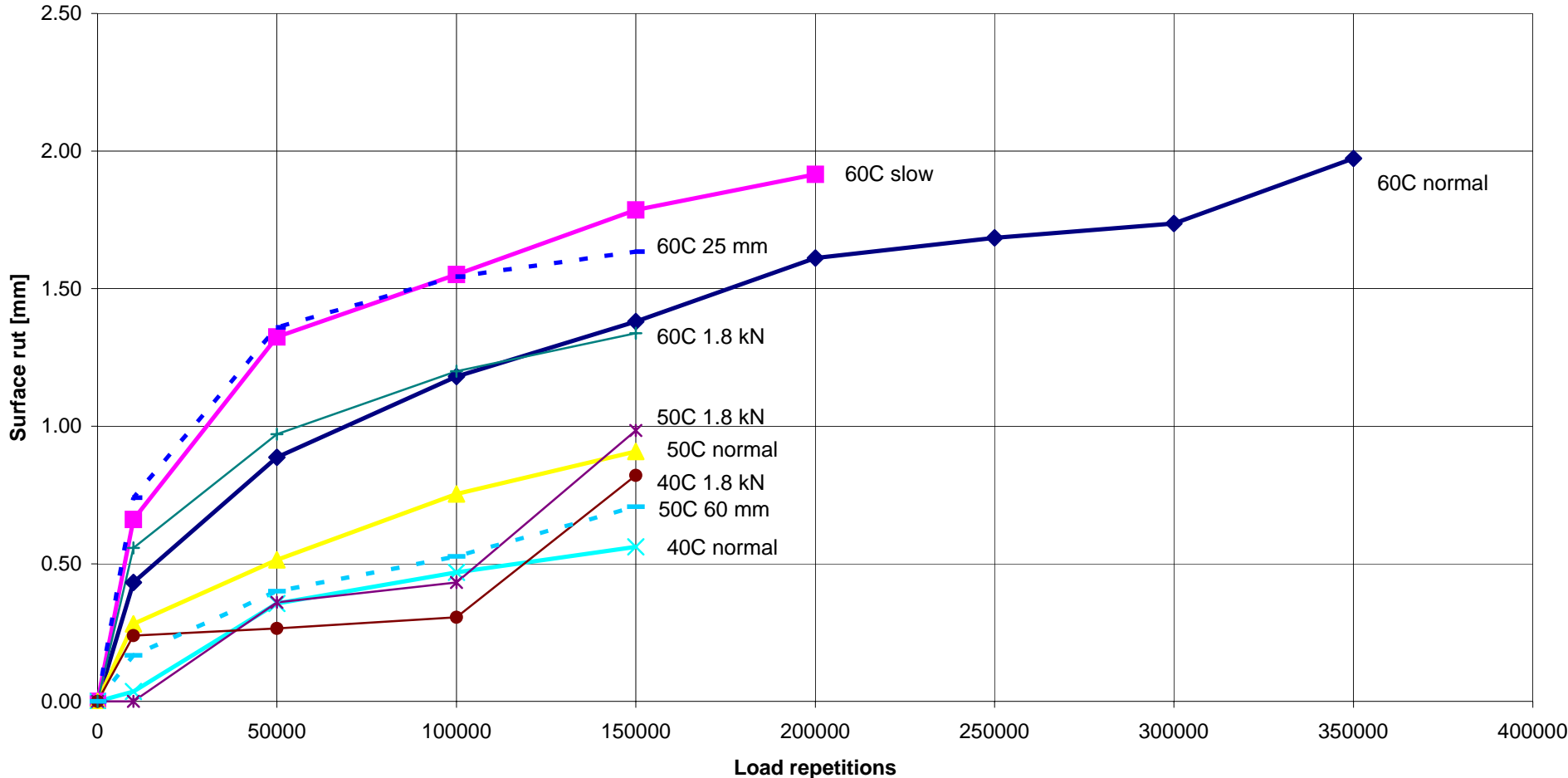
- Both HVS and MMLS3 test conducted
- Similarities in overall outputs for parameters
- Scale factors are different
- Concerns regarding
 - Distribution of stresses inside HMA
 - Test conditions – speed, temperature etc
 - Need for detailed analysis



HMA testing: Standard mix – MMLS3

MMLS tests on R80

No legend on parameter indicate 40 mm, 2.9 kN, normal speed



HMA testing: Standard mix – APT - Conclusions

- Thickness
 - 25 similar to 40 but look at voids
 - 60 better than 25 and 40 but not economically better
- Temperature
 - Major sensitivity for higher temperatures – especially when fresh
- Contact stress distribution
 - Does affect rut
- Uni- vs Bi-directional
 - Thin aged sections do not appear to be critical
- Wandering vs Channelised
 - Shoving of material at temperature – look into phenomenon for intersections
- HVS vs MMLS3
 - Similar individual patterns, concern over stresses inside layer



HMA testing: Standard mix - Laboratory

- Objective
 - Identify test methods and protocols that can be used to assess permanent deformation characteristics of HMA



HMA testing: Standard mix – Laboratory - Progress

- Laboratory testing phase completed
- Data processed and analysed
- Report nearing completion, content covers
 - First level data analysis
 - Advanced data analysis
 - Future direction of research
- Current work involves FEA of laboratory and field tests for comparative purposes
- Conference and journal papers under preparation



HMA testing: Standard mix – Laboratory - Findings

- Achieved densities
 - 25 mm field sections under-compacted
 - 40 mm field sections compacted to target density
 - 60 mm field sections over-compacted
- Short term ageing is effective way of conditioning lab –produced HMA samples to simulate post construction field condition
- ITS results indicate that slab and gyratory compaction more closely simulate field compaction than Marshall
- Gyratory refusal density requirements to be scrutinized, currently indicate mix to be suitable for heavy traffic situations
- Wheel tracking tests provide consistent results
- Interpretation of dynamic creep results to be revisited



HMA testing: Standard mix – Laboratory - Findings

- Static creep test not relevant for situations with moving traffic (contrary to indication in TMH-1)
- RSST-CH provides valuable information on permanent deformation behaviour
- No reliable water permeability test available
- No correlation Marshall stability and flow with rut, performance in the field (confirming other studies)



HMA testing: Standard mix – Laboratory - Conclusions

- Thin layers may have permeability and durability problems
- Most tests indicate mix to have medium permanent deformation resistance
- Need to update test protocols based on the findings
- Suitable tests identified for next phase (rut challenge mixes)



HMA testing: Standard mix – Level 2 analyses

- Already started with Level 2 analyses of data
- Some papers and reports already done
- Further work once Technical memoranda completed



HMA testing: Standard mix – So What

- Boundaries for usage – temperature, traffic type, wander effects
- Practical guidelines when and where to use
 - Intersections, climatic conditions
- Limitations re outcomes
 - Slow speed (intersections), 1 binder evaluated, 1 mix evaluated
- Thickness
 - Thinner (25 mm) and thicker (60 mm) options apparently not worth it
- Construction control
 - Compaction



HMA testing: Rut resistant mixes

- 3 rut resistant mixes planned
- Same site as previous tests
- Test programme based on outcomes of previous APT and laboratory
- April 2008 to September 2008
- HVS
 - 8 weeks of testing
 - 60°C, standard load, channelised, **uni**-directional – 6 weeks / xxx repetitions
 - 60°C, standard load, channelised, **bi**-directional – 6 weeks / xxx repetitions
 - Comparison of data with standard mix
 - Concern regarding possible wandering test – wait for 450A4 – current test

