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Upgraded Roller Trial Report Ver 3.doc
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Dear Jodi

Modified Heavy Roller Trial

The modified heavy roller was trialled on prepared but unproven base course material at RAAF Base Amberley on 22 March 2007. The trial was located on the apron being constructed for use by the MRTT aircraft. This letter details the trial as well as the roller capability and may be used to form the basis of a supplement to the Heavy Roller Operating Manual.

Photographs from the roller upgrade work and field trial are contained in **Annex A**.

Introduction

Following the reduction in the certifiable tyre pressure for the heavy pneumatic tyred (PT) roller fleet tyres by the tyre manufacturers (Michelin), the rollers capability was affected. Analysis of induced stresses showed that the rollers remained capable of meeting the requirements for proving granular materials under concrete pavements and subgrades. However, the upper granular base course layer(s) of flexible pavements were not able to be proven at the reduced tyre pressures. Following an investigation of alternate roller tyre options, and due to the urgency of solving the issue, Defence determined that the most practical option in the short term was to fit steel wheels with a relatively thick solid urethane rubber outer to a few of the existing rollers. Defence then commissioned the upgrading of one of the existing rollers as a prototype to permit evaluation.

Modified Roller

The roller was modified by Leighton Contractors. The upgraded roller is shown in **Photograph 1**. The urethane rubber 'tyre' was designed, supplied and applied by Uretech Industries (Melbourne). The stiffness of the urethane was to be designed



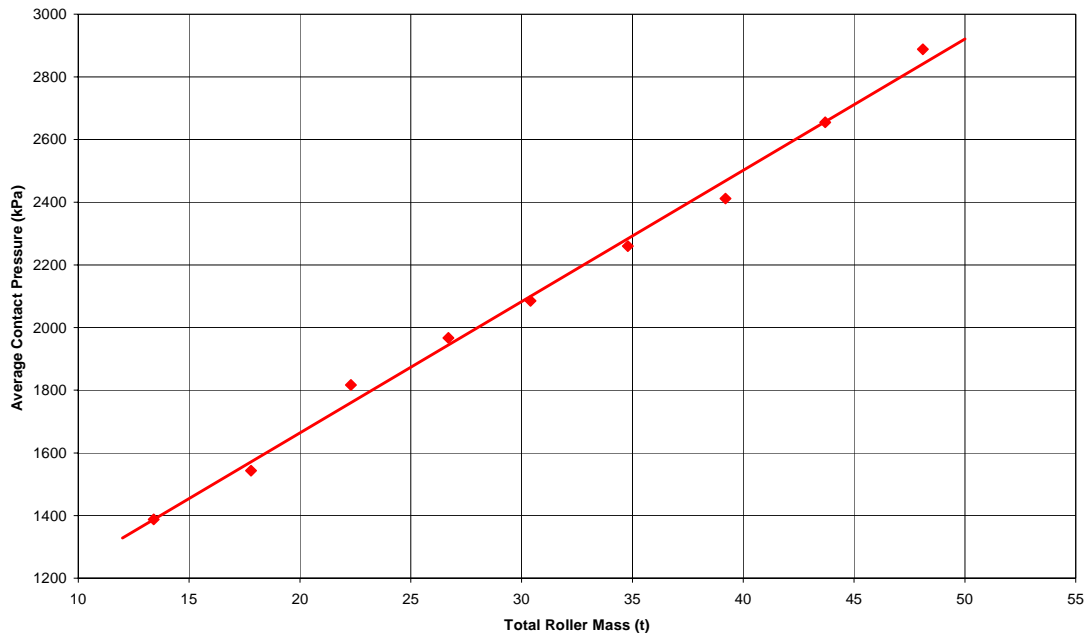
such that with a 10 tonne per wheel loading, the contact area between the wheel and the base course would result in an effective contact pressure of 1700 kPa.

Initially, urethane test segments were manufactured and tested in a hydraulic press to confirm that the required contact pressure would be achieved. Following this testing, although the contact pressure was significantly higher than required (by 400kPa), the material was accepted and the wheel coatings were applied in conjunction with other roller improvements and maintenance. The urethane outer is shown in **Photograph 2**.

As part of the upgrade works, shields were fitted over the wheel to minimise the urethane's UV exposure as shown in **Photograph 3**. The original ballast weights were also 'boxed' into groups. It is understood that this was required for OHS reasons, primarily relating to the need to certify lifting lugs for each weight if they remained separate. Efficiency is also achieved in manoeuvring a smaller number of boxed weights rather than more separate weights. These are shown in **Photograph 4**.

One half of the roller (2 wheels) was tested by Leighton's to check contact pressure. This confirmed that even higher contact pressures than the preliminary tests indicated were realised with the urethane.

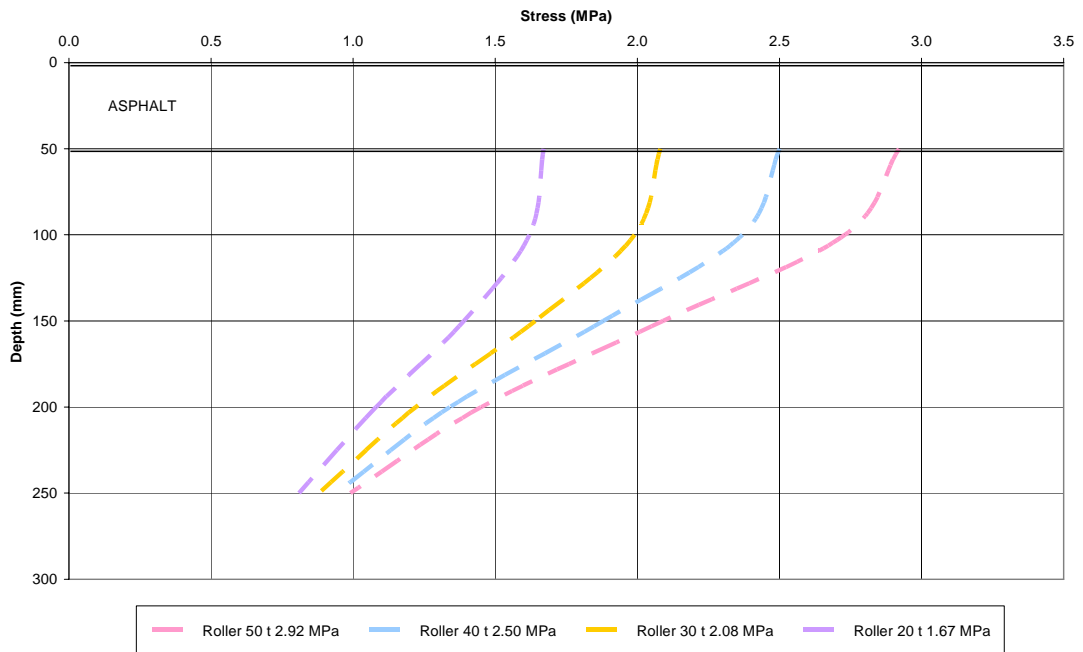
As the effective contact pressure can not be adjusted except by increasing or decreasing the wheel loads, there is only one variable in the selection of the roller configuration, which is roller mass. This contrasts with the original rollers where both mass and tyre pressure could be independently adjusted, subject to operational limits. A graph of the effective contact pressure versus total roller mass is shown below for the modified roller.



It is noted that the effective contact pressures are average pressures over the whole contact area. No analysis has yet been conducted on the uniformity or otherwise of the contact pressure. Such analysis is recommended for the future.

Proof Rolling Capability

The upgraded roller has been designed only for the purposes of proving the upper base course layers. In these layers, high tyre contact pressures at the finished asphalt surface remain high before being dissipated in the underlying pavement thickness. The stress with depth induced by the upgraded roller is presented in the following graph for a range of total roller masses and their corresponding contact pressures.



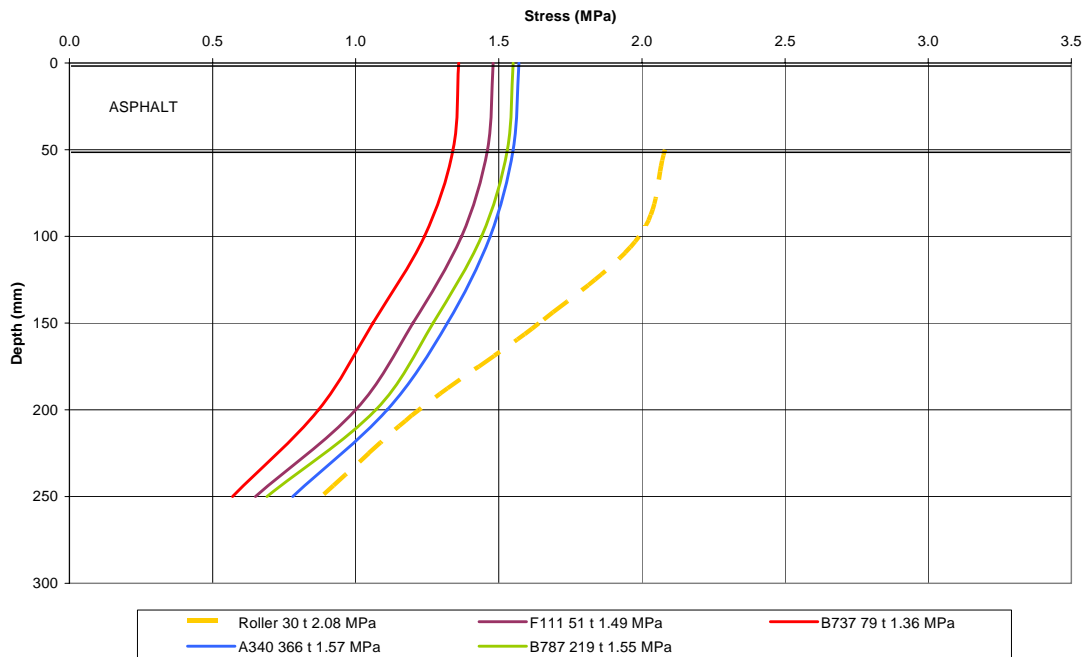
The roller stress with depth plot commences at 50 mm to allow for the minimum thickness of asphalt placed above the base course. The stress with depth in this case has only been calculated for a thickness of 200 mm as this is the maximum likely thickness of a single layer of base course material. At greater base course thicknesses, the base course would be placed in two or more layers and the proof roller would be applied to each layer.

Stress with depth plots have been generated for a number of aircraft, including those considered to be the most severe on thin asphalt surfaced flexible pavements.

The aircraft considered were:

- F111. High tyre pressure and significant mass on a single wheel.
- B737-800. Heavy aircraft for a dual wheel configuration.
- A340-600. Highest ACN of all current aircraft in operation.
- B787-800. Under development aircraft expected to replace the B767 in Australia.

The following graph shows stress with depth plots for these aircraft. The upgraded roller at 30 t total mass is included for reference.



From the above graph, it can be seen that for a minimum of 50 mm of asphalt surface and a maximum base course layer thickness of 200 mm, the upgraded roller at 30 t total mass induces stresses that exceed those induced by the aircraft considered. The upgraded roller at 30 t is therefore adequate for proving base course layers of 200 mm thickness or less, designed to cater for the aircraft considered. As these are some of the most damaging aircraft on flexible pavements, the upgraded roller would appear to be more than capable of proving all likely flexible pavement base course layers.

Field Trial

During the field trial on 22 March 2007 at RAAF Base Amberley, the roller was operated on a section of compacted but unproven base course to apply 12 coverages of the roller wheels. The test area is shown in **Photograph 5**. The roller was initially operated free of ballast. It was then operated at a total mass of 40 t. Before operation and after each loading, the pavement surface was assessed for:

- Insitu density by nuclear densometer.
- Deformation by measuring the gap under a string line with a graduated wedge.

The surface was also visually inspected for tightness, deformation and surface damage. **Photograph 6** shows the roller being operated during the trial.



The results of the deformation measurement and density testing is shown in the following tables. Test locations are detailed in **Annex B**.

Location	Initial Density	Density after rolling
1	100.6%	103.9%
2	99.0%	102.6%
3	97.8%	101.0%

Location	Initial deformation (mm)	Deformation after rolling (mm)
SL1	A	0
	B	0
	C	1
	D	1
SL2	A	2
	B	5
	C	4
	D	2
SL3	A	0
	B	2
	C	2
	D	2

* Located within area that deformed due to pore pressure instability during rolling

The base course surface is shown before testing in **Photograph 7** and after testing in **Photograph 8**.

Based on the density and deformation testing and the visual inspection of the pavement surface, the following conclusion were made:

- No surface damage occurred at the edges of the solid wheel or other location, except where pore pressure created a localised instability and surface disturbance occurred.
- While the surface of the proof rolled FCR did not appear to be loosened, it was also not significantly tightened, as occurs with pneumatic tyres. This outcome may be overcome by use of a softer urethane material in subsequent upgrades.
- Aggregate particles did not crush or break under the very high contact pressures.
- The roller was effective at further increasing the density of the base course material to a degree that is considered typical for proof rolling (ie 3-4%).



- Deficiencies in the density of the base course were identified by the higher stresses as expected.

It is noted that the boxing together of the ballast weights requires further investigation and may need rationalisation so that common roller masses can be evenly distributed across the four roller wheels. Defence should also consider additional testing to determine the uniformity of the contact pressure over the tyre contact area.

Operating Restrictions

Due to the nature of the urethane wheel coating, a number of operating restrictions are proposed. These are:

- Storage of the roller should be undercover to minimise the urethane's exposure to UV radiation.
- The roller should be restricted to use on base course layers of high strength flexible pavements as only these layers are required to resist the very high contact pressures of the upgraded roller and provide a flat surface for the solid wheels.
- Rolling speeds should not exceed 6 km/h when loaded as for pneumatic tyred rollers.
- It is apparent that the average contact pressure under the solid tyres is approximately 800 kPa greater than originally proposed. While no significant detrimental effects are apparent at present, the roller has only been subjected to a limited trial. Further use in full scale construction on a variety of FCR materials is required to gain a full appreciation of the tyre behaviour.



If you have any queries regarding this report or require further information, please do not hesitate to contact the undersigned at any time.

Yours sincerely

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Annexes:

A. Photos.

B. Test Locations.



ANNEX A Photographs



Photograph 1. Upgraded roller overview.



Photograph 2. Urethane coating.



Photograph 3. UV shield.



Photograph 4. Boxed ballast.



Photograph 5. Test Area.



Photograph 6. Roller operation.



Photograph 7. Surface before rolling.



Photograph 8. Surface after rolling.



ANNEX B Test Locations

