ROADEX Network Implementing Accessibility
Tyre Pressure Control

ROADEX IV final seminar
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Outline of the presentation

- Basic idea of CTIS/TPCS
- Historical development
- Effect of TPC on wheel/road contact
- Principle of operation to reduce tyre wear
- Effect of TPC on road stresses
- Effect of TPC on traction/mobility
- Effect of TPC on driver’s health (by Johan Granlund tomorrow)
- TPC installation statistics in some of the ROADEX countries
Basic idea of CTIS/TPCS

CTIS = Central Tyre Inflation System
TPCS = Tyre Pressure Control System
Historical development

- 1942 US amphibious landing craft

Material borrowed from Allan Bradley, FPInnovations FERIC, Canada
Historical development

- 1944 - 1960 widespread development and use in military applications by Soviet Union
- 1960 - 1970 also in many civil applications

Material borrowed from Allan Bradley, FPInnovations FERIC, Canada
Historical development

- Widespread adoption by US and western European militaries in 1990s;
- By 1990, 30+ types of CTI used around world

- In 1982, USFS began CTI research program; applied to various forestry vehicles
- In 1993, first two TPCS for commercial trucks

Material borrowed from Allan Bradley, FPInnovations FERIC, Canada
TPCS components
Effect of TPC on wheel/road contact

Material borrowed from Allan Bradley, FPInnovations FERIC, Canada
Effect of TPC on wheel/road contact

A higher tyre pressure concentrates the weight of the vehicle on to a small contact surface area.

A lowered tyre pressure creates a longer footprint and distributes the weight of the vehicle over a larger area.

Effect of TPC on wheel/road contact

- Rut shape: Wider, shallower rut
- Stiffness and spring rate: Less impact energy
- Contact area: Lighter footprint, more tread
- Contact stress distribution: Material borrowed from Allan Bradley, FPInnovations FERIC, Canada
Effect of TPC on wheel/road contact

- High pressure
- Low pressure
- Steep incline
- Shallow incline

Less motion resistance in the direction on driving → better mobility of the vehicle

Material borrowed from Allan Bradley, FPInnovations FERIC, Canada
Uncontrolled tires are over-inflated for 75% of the trip → less tyre wear with the use of TPC

Material borrowed from Allan Bradley, FPInnovations FERIC, Canada
Effect of TPC on road stresses - Field trial at Stynie Woods, Scotland
Installation of the earth pressure gauges
Pressure distribution at full tyre pressure under the front wheel.

Pressure distribution as a function of depth as expected.
Effect of tyre inflation pressure on road stresses

- Low tyre pressure
- Medium tyre pressure
- High tyre pressures
Effect of TPC on road stresses

Stresses are reduced near to the road surface but much less deeper in the subgrade $\rightarrow$ TPC helps on Mode 1 rutting, but not on Mode 2
Calculated effect of lowered tyre pressure

Vertical stress, kPa

Depth, mm

Material borrowed from Allan Bradley, FPInnovations FERIC, Canada

Largest stress reductions occur in surfacing and base layers
Effect of TPC on traction /mobility - Filed trial at Niinisalo, Finland
Effect of TPC on traction/mobility
Field trial at Niinisalo, October 2011
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Peak value before sliding of the tyre

![Graph showing peak value before sliding of the tyre with different symbols for wetted steel plate, gravel, empty truck, and oiled steel plate.](graph.png)
Effect of TPC on traction/mobility
Field trial at Niinisalo, October 2011

Diagram: Sliding tyre

- Wetted steel plate
- Gravel, empty truck
- Oiled steel plate

Graph showing pulling force (kN) against tyre pressure (kPa) for different conditions.
Effect of TPC on traction/mobility
Results obtained on loose / soft surface

<table>
<thead>
<tr>
<th>Road surface</th>
<th>Highway inflation (kPa)</th>
<th>TPCS tire pressure (psi)</th>
<th>Measured tractive increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loose gravel*</td>
<td>610</td>
<td>210</td>
<td>42%</td>
</tr>
<tr>
<td>Sugar sand</td>
<td>690</td>
<td>450</td>
<td>34%</td>
</tr>
<tr>
<td>Wet clay</td>
<td>690</td>
<td>450</td>
<td>17%</td>
</tr>
</tbody>
</table>

* Less or no tractive hop at reduced tire pressure

Material borrowed from Allan Bradley, FPInnovations FERIC, Canada
Effect of TPC on traction /mobility - Wintertime filed trial at Ivalo, Finland

Uphill profile at the Nokian Tyres test site:

10% 200 m
17% 160 m
23% 50 m
Effect of TPC on traction /mobility - Wintertime filed trial at Ivalo, Finland
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<table>
<thead>
<tr>
<th>Tyre inflation pressures (kPa)</th>
<th>Climbing distance (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full pressure in all tyres</td>
<td>370</td>
</tr>
<tr>
<td>’Medium’/350 kPa in driving wheels</td>
<td>380</td>
</tr>
<tr>
<td>Low / 220 kPa in driving wheels</td>
<td>379 - 380</td>
</tr>
</tbody>
</table>
Effect of TPC on traction/mobility - Wintertime filed trial at Ivalo, Finland

A heap of snow in front of the trailer wheels in the low pressure drive.
TPC installation statistics in some of the ROADEX countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Year of the first TPCS installation</th>
<th>Approximate number of installations today</th>
</tr>
</thead>
<tbody>
<tr>
<td>United Kingdom</td>
<td>2006</td>
<td>About 100</td>
</tr>
<tr>
<td>Sweden</td>
<td>2003</td>
<td>&gt; 130</td>
</tr>
<tr>
<td>Finland</td>
<td>2009</td>
<td>&gt;10</td>
</tr>
</tbody>
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Questions ?