

**8th ICAP - Seattle, USA**

*ICAP '97*

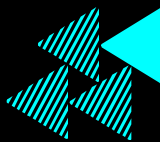
***Session : Traffic/Loading Considerations***

**DETERMINATION OF PNEUMATIC  
TYRE/PAVEMENT INTERFACE  
STRESSES UNDER MOVING LOADS  
AND SOME EFFECTS ON PAVEMENTS  
WITH THIN ASPHALT SURFACINGS**

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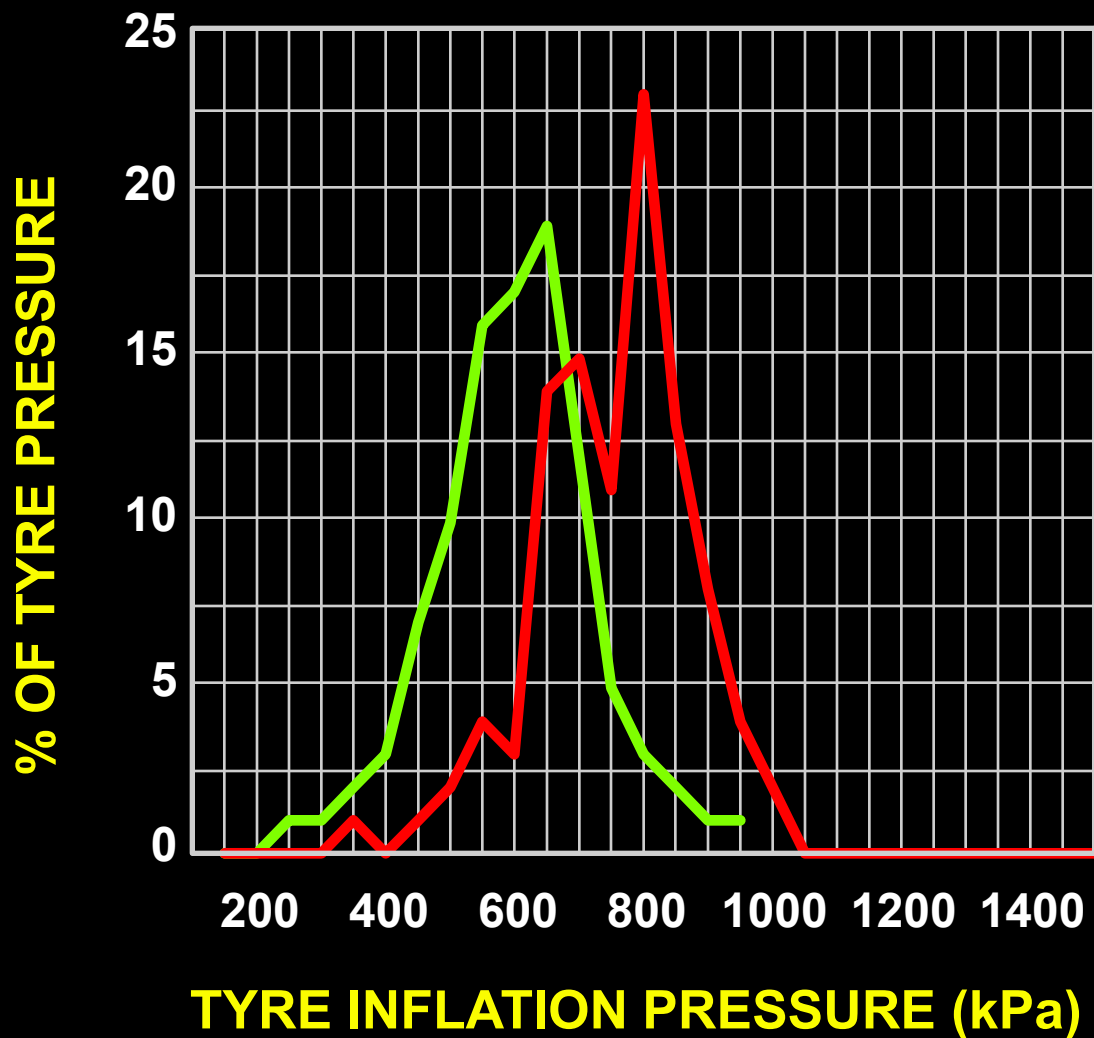
**CSIR**

**COURSE PROGRAMME**  
**FRIDAY, NOVEMBER 28, 1997**

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*APPENDIX H:*  
*TYRE/PAVEMENT CONTACT*  
*STRESSES BASED ON THE*  
*Stress-In-Motion (SIM) systems*  
**(Dr M De Beer)**





Average: 620 kPa  
(1974)

Average: 733 kPa  
(1995)

TYRE INFLATION PRESSURE (kPa)

FIGURE 1a

Tyre inflation pressure distributions in South Africa (1974 - 1995)

# Heavy vehicles: Axle Loads > 7 000 kg Survey: 1995

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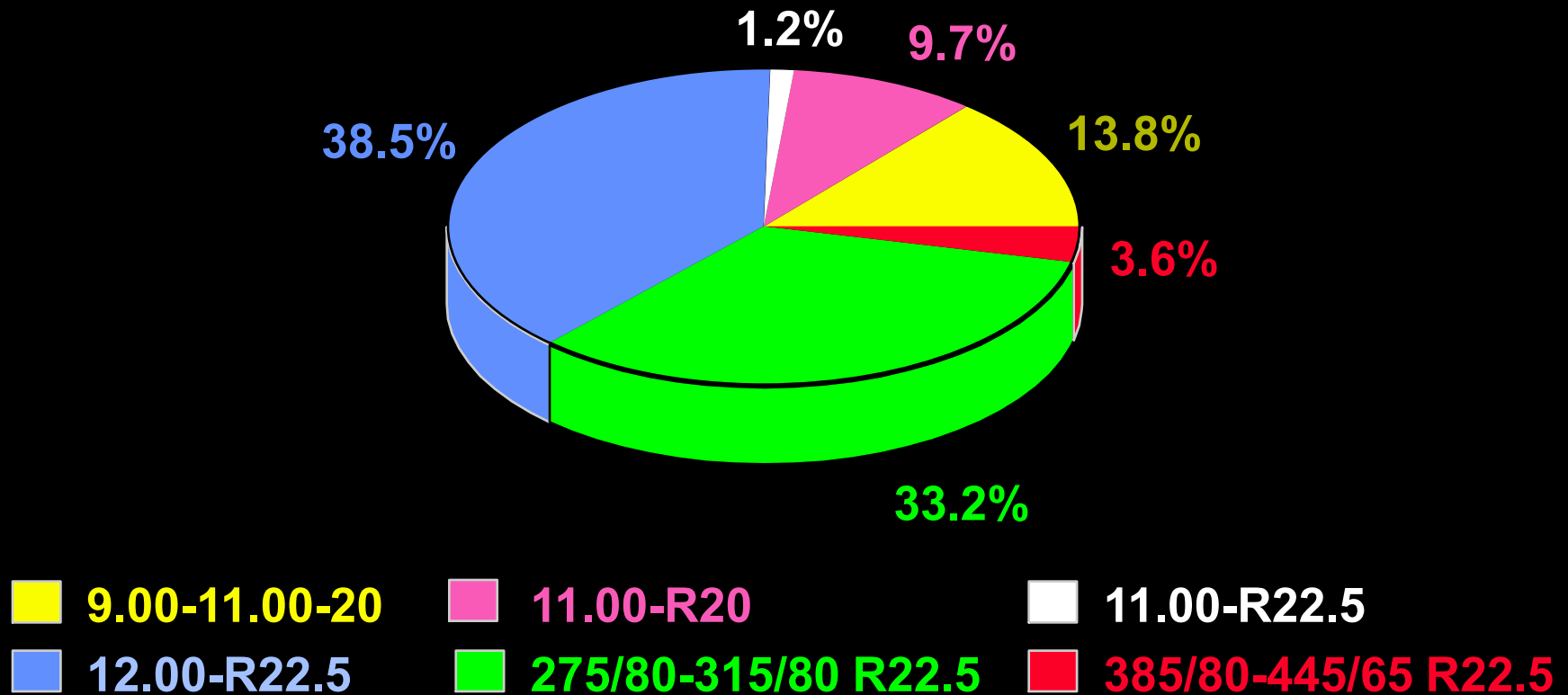


FIGURE 1b

## Distribution of heavy truck tyre types in South Africa

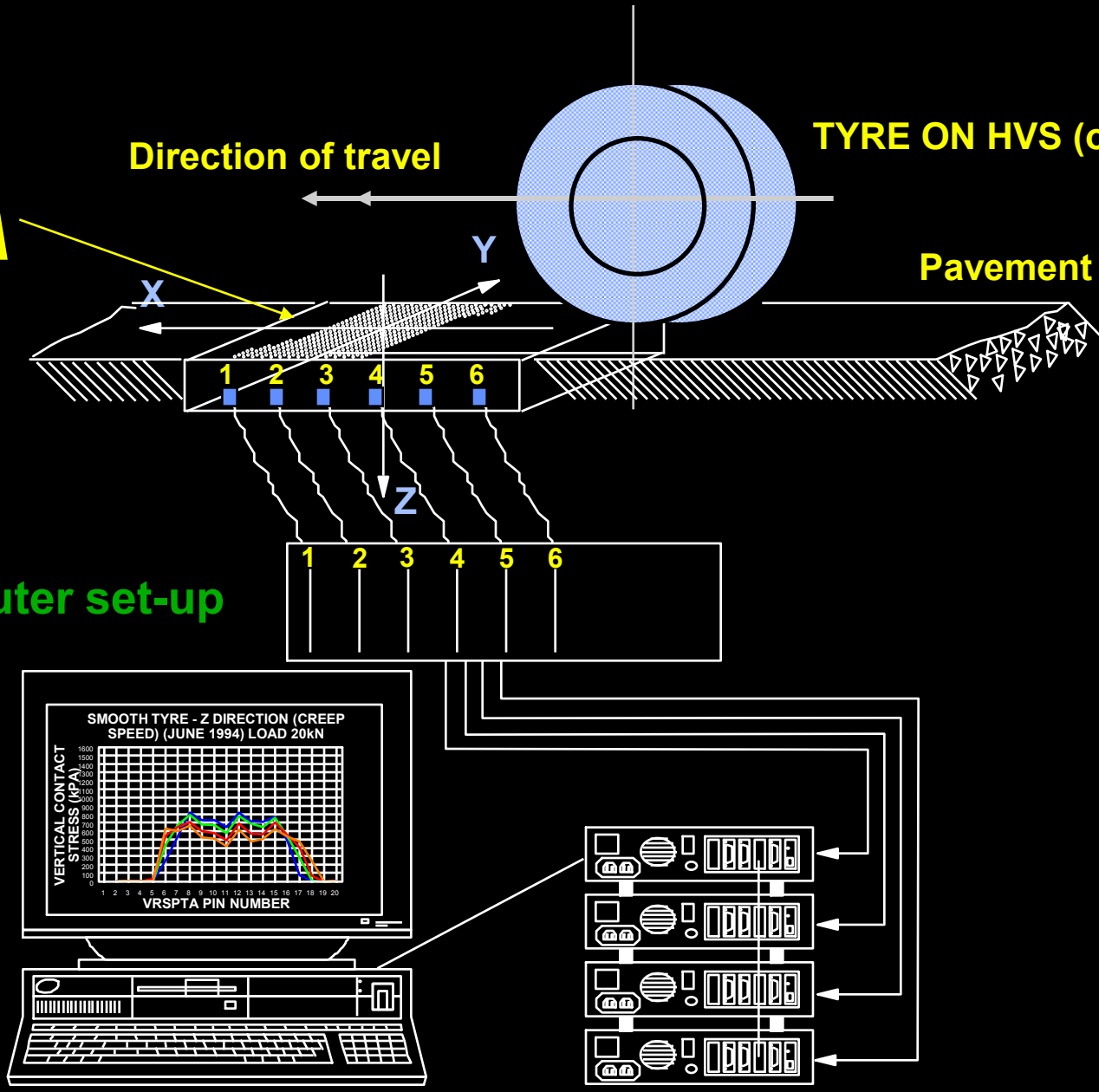
**VRSPATA**

Direction of travel

**TYRE ON HVS (or Vehicle)**

**Pavement Surface**

**Computer set-up**



**FIGURE 2**

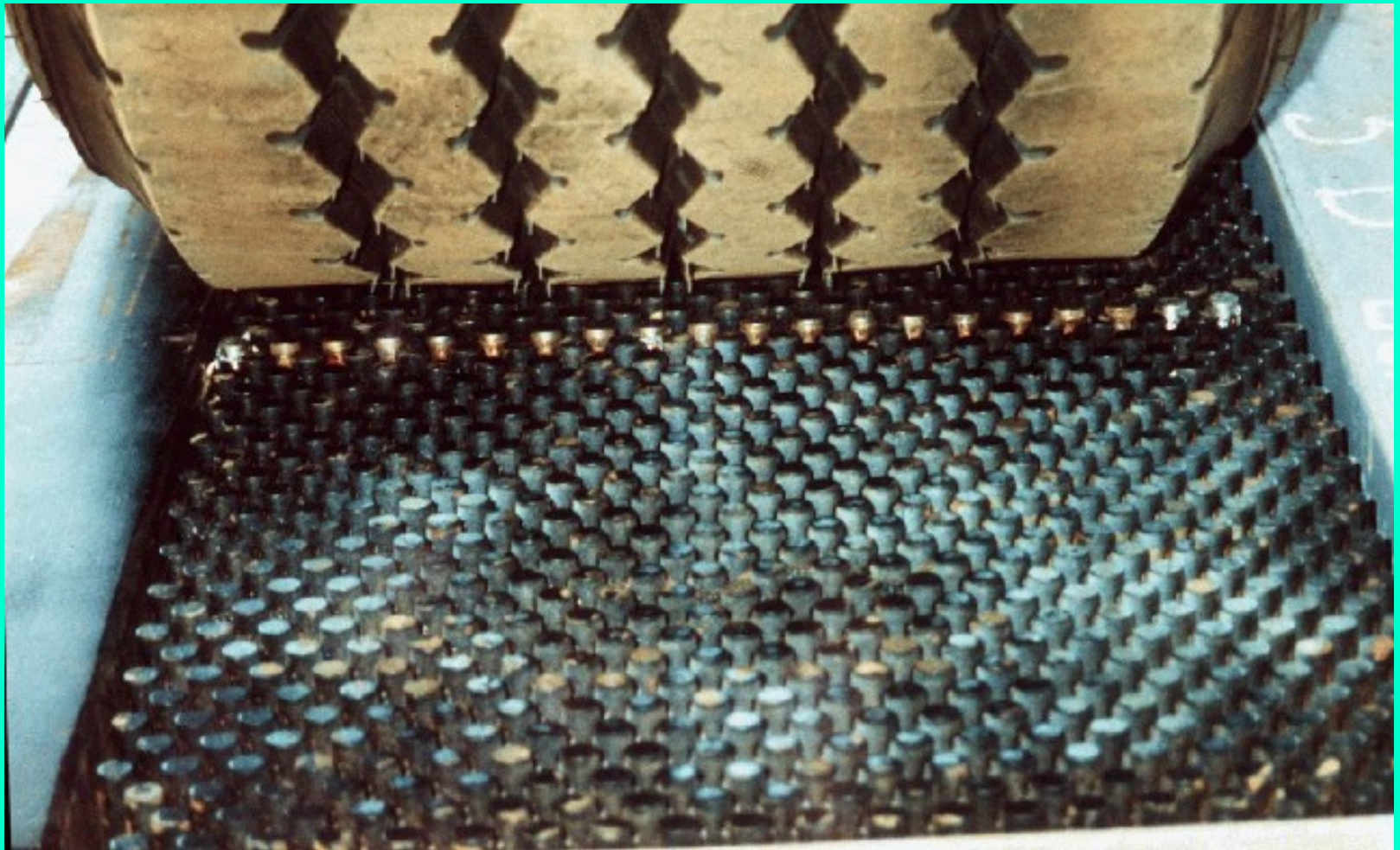
**Schematic layout of VRSPATA system**



**VEHICLE-ROAD SURFACE PRESSURE TRANSDUCER ARRAY (VRSPTA)**



***315/80 R22.5 HVS TYRE ON VRSPTA***



***425 /65 R22.5 HVS TYRE ON VRSPTA***



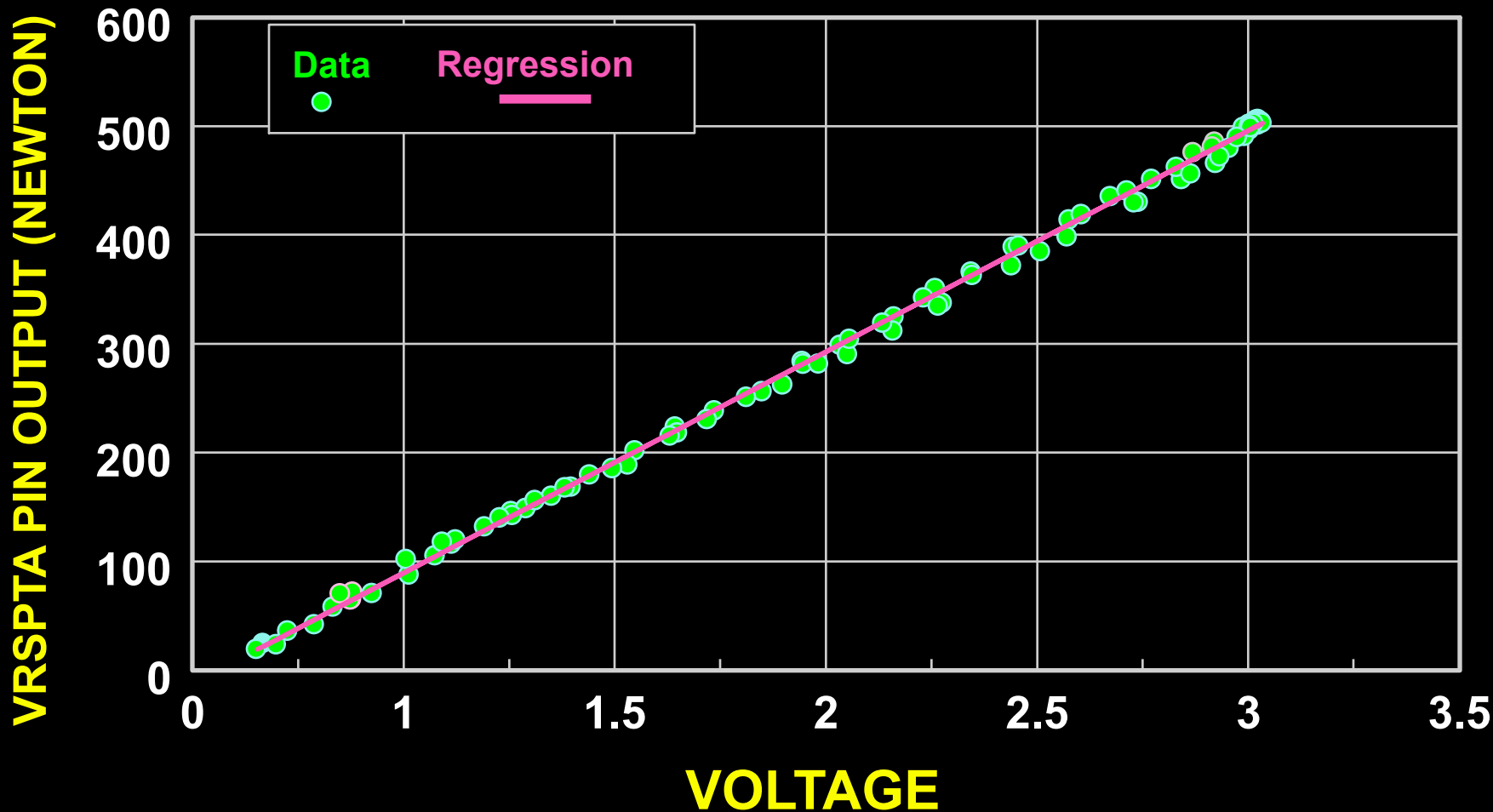


FIGURE 3

Laboratory calibration data of VRSPTA pins

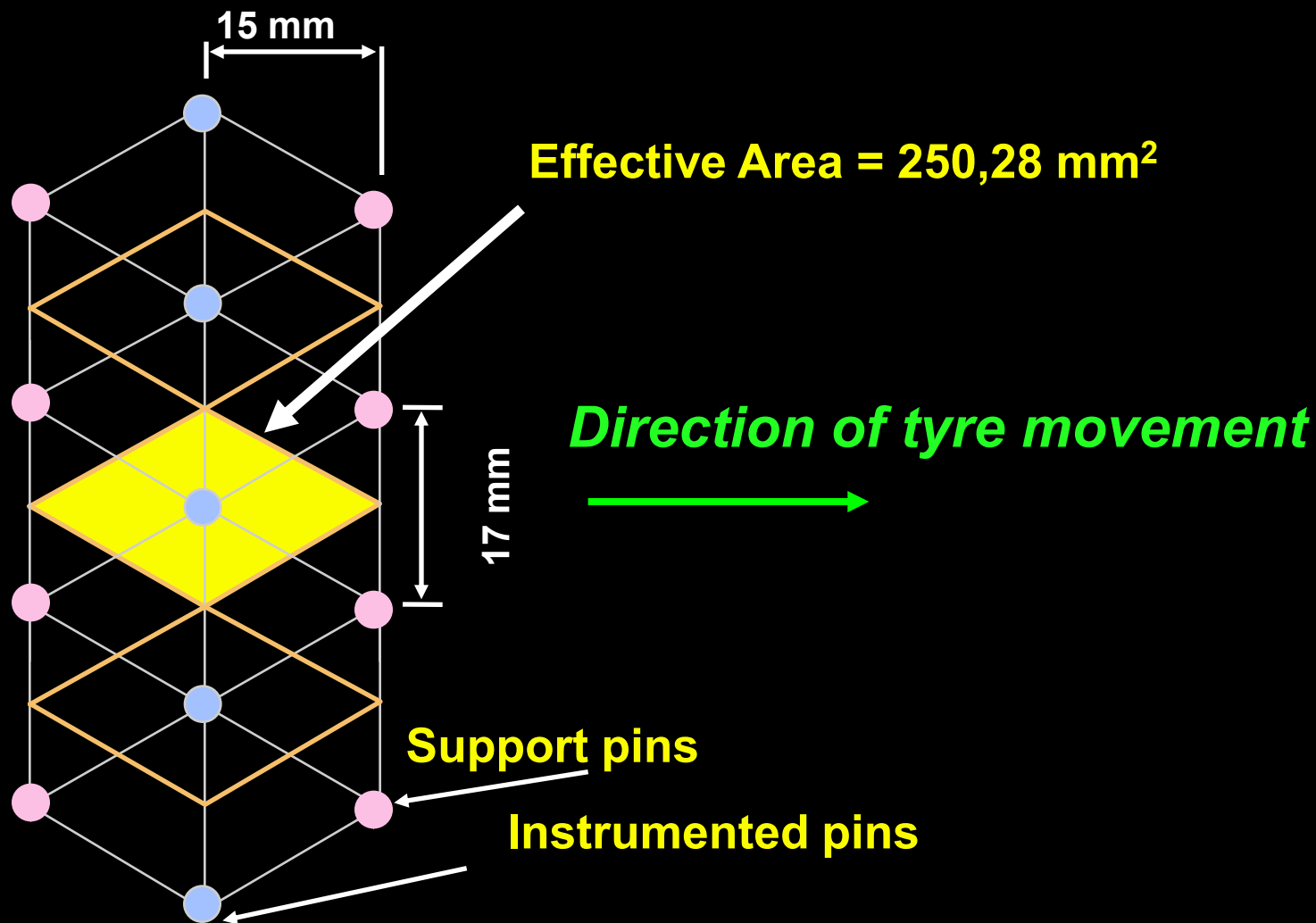


FIGURE 4

**Effective Diamond Shaped Area used for the contact stress calculation in VRSPTA**

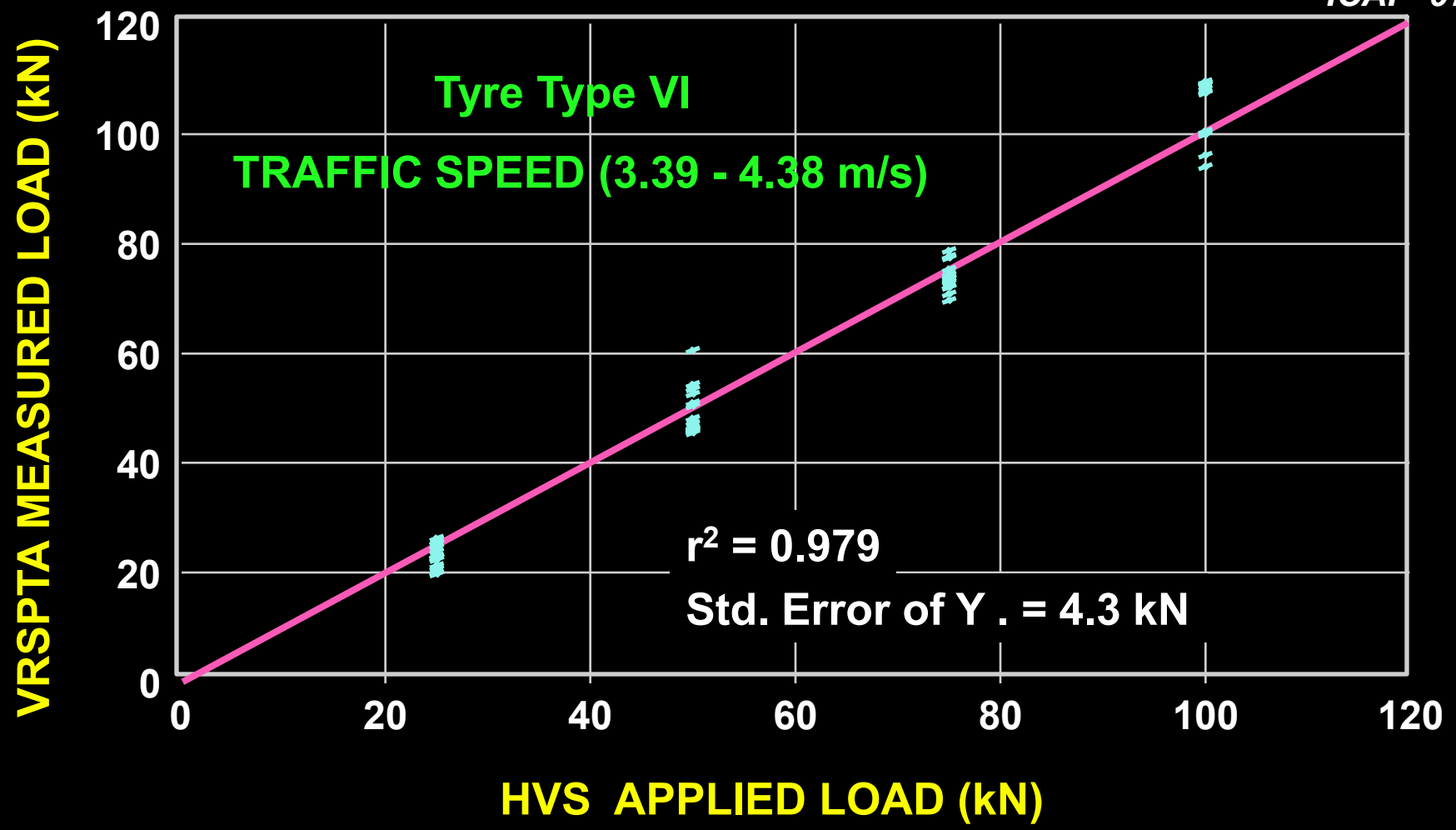


FIGURE 5

Accuracy of the VRSPTA relative to HVS applied load (random error)

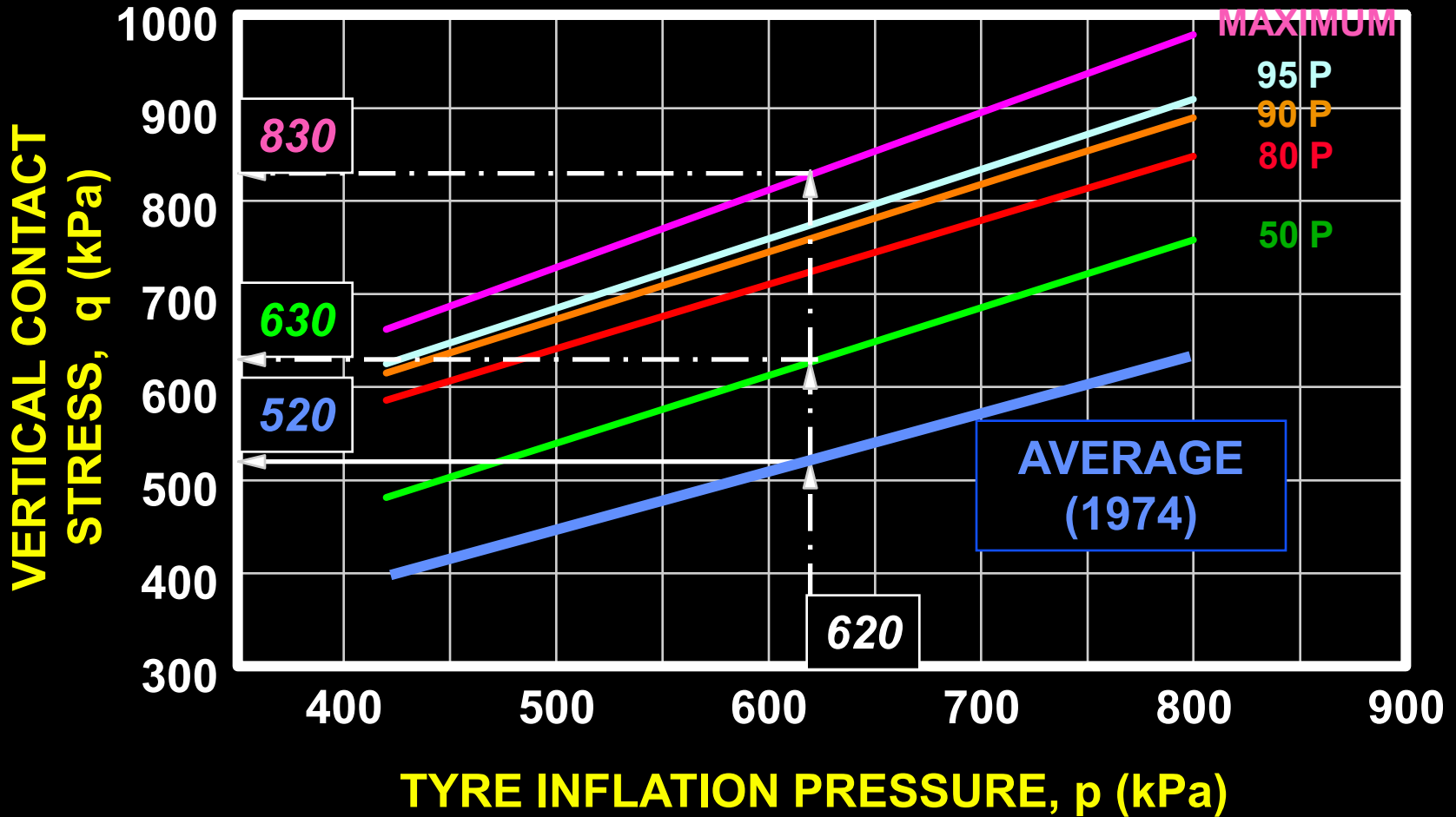
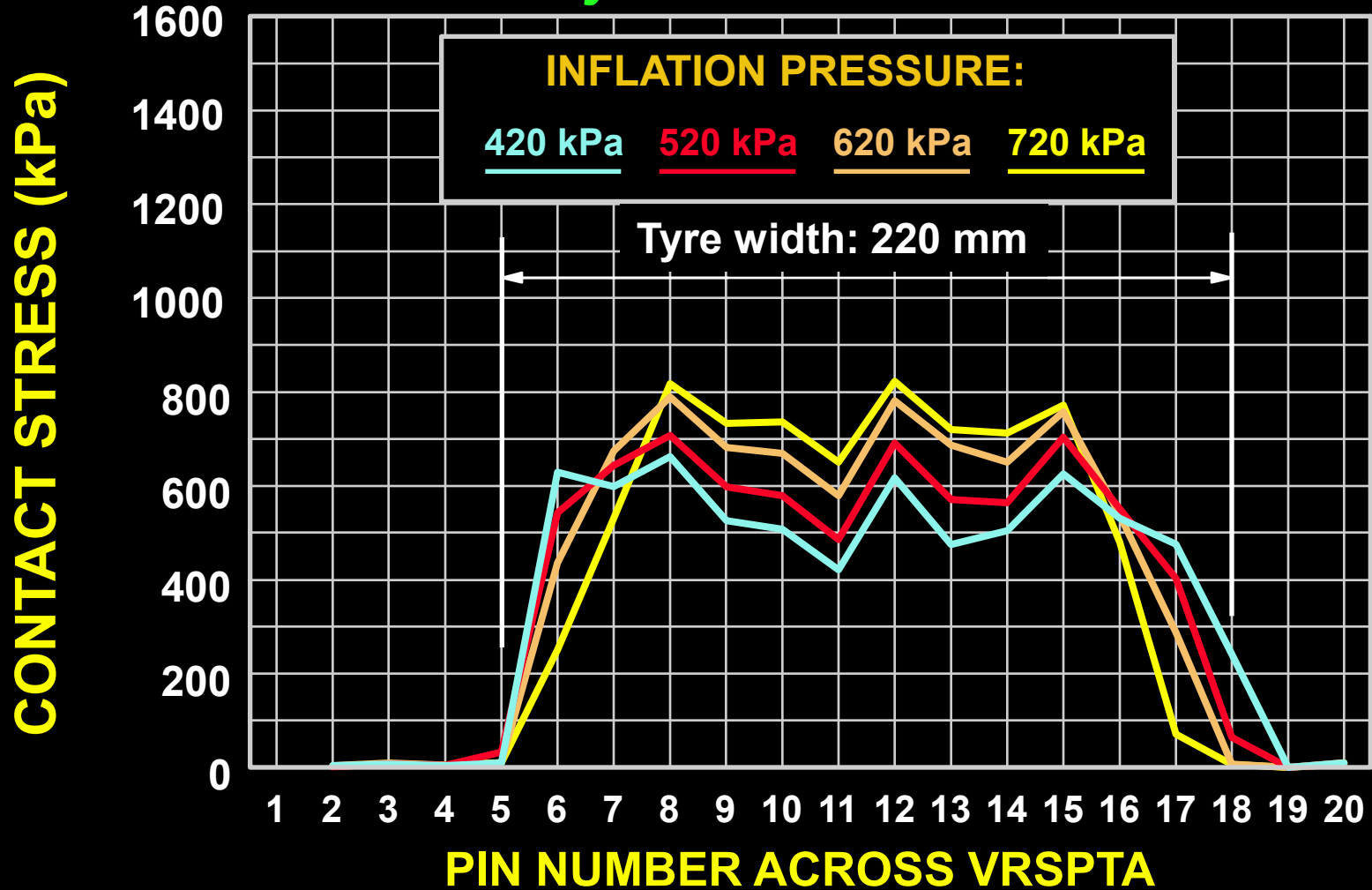


FIGURE 10  
"Average" vertical contact stress vs inflation pressure

**Tyre Load = 18 kN**

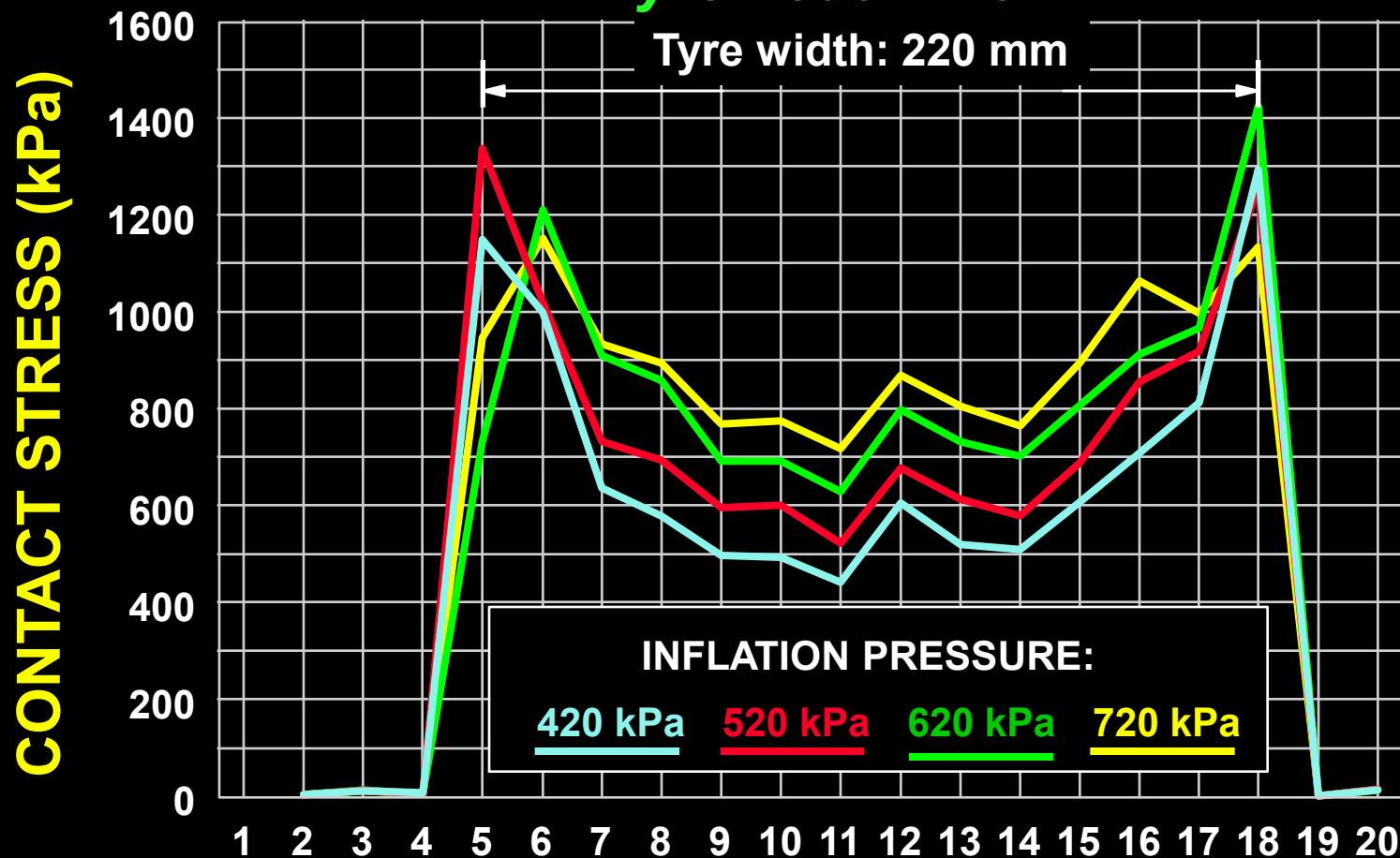


**FIGURE 11**

**Maximum vertical stress at CONSTANT LOAD and various inflation pressures**

**Tyre Load = 49 kN**

**Tyre width: 220 mm**



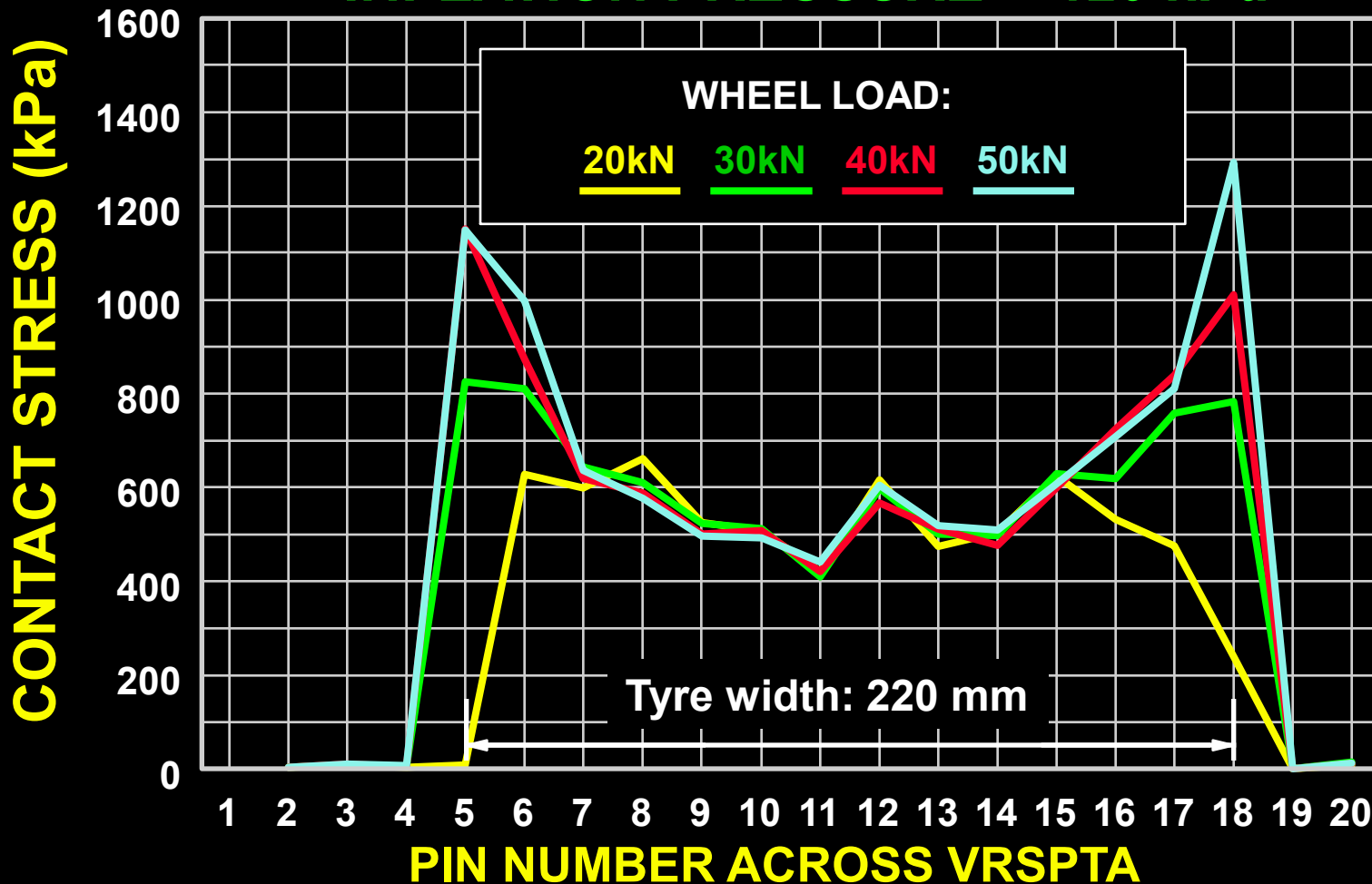
**PIN NUMBER ACROSS VRSPTA**

**FIGURE 12**

**Maximum vertical stress at CONSTANT LOAD and various inflation pressures**



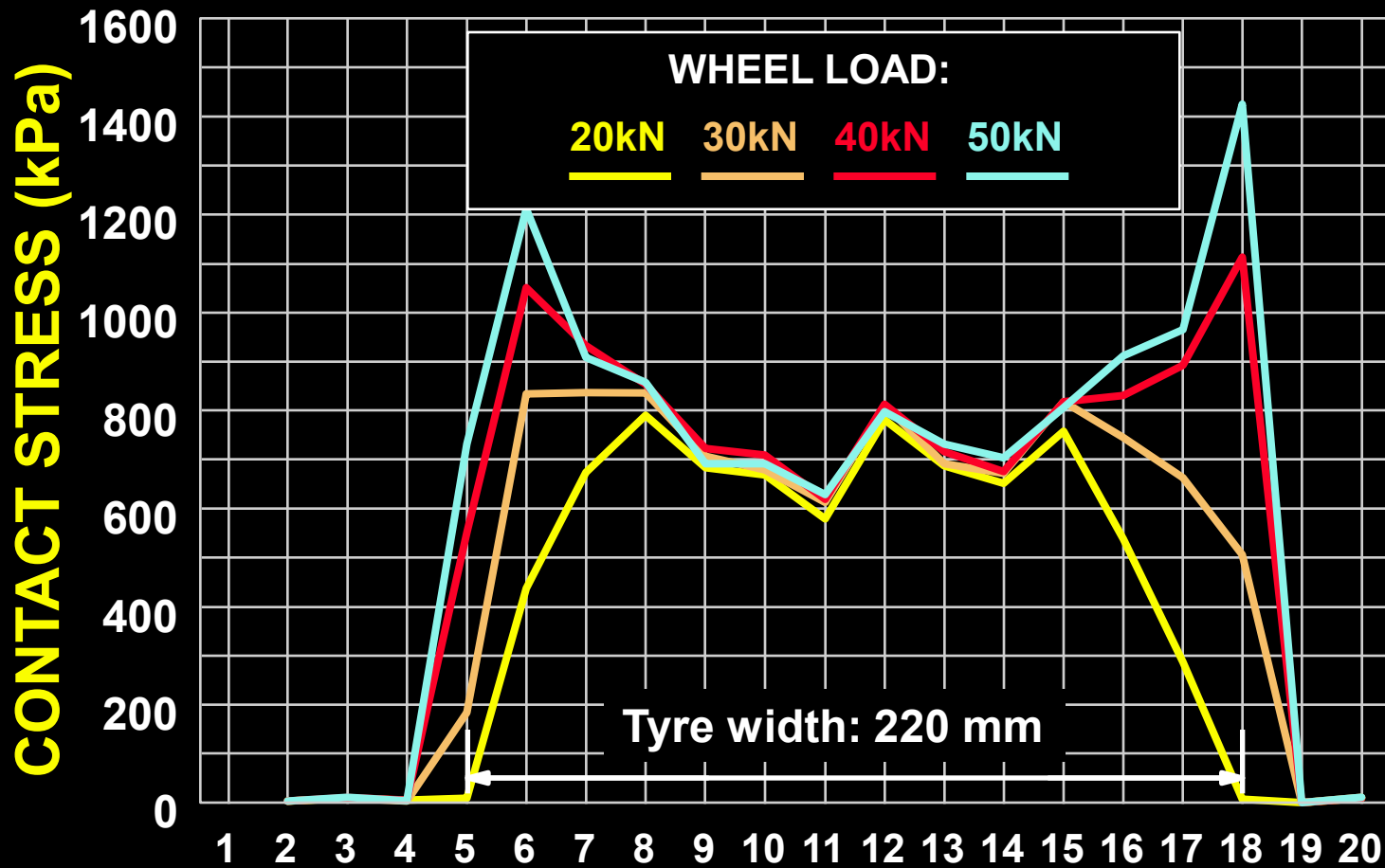
**INFLATION PRESSURE = 420 kPa**



**FIGURE 13**

**Maximum vertical stress at CONSTANT INFLATION PRESSURE at various loads**

**INFLATION PRESSURE = 620 kPa**



**PIN NUMBER ACROSS VRSPTA**

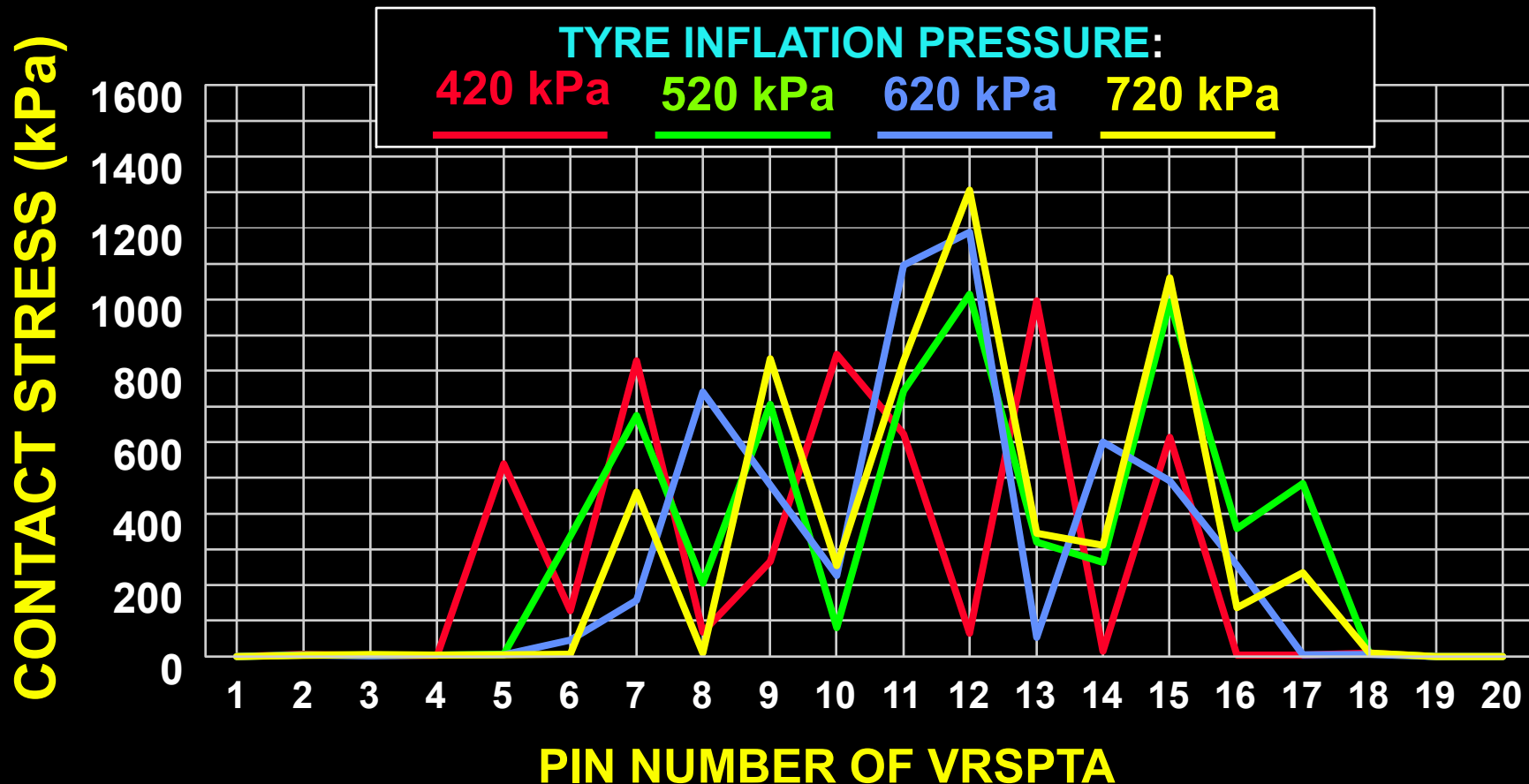
**FIGURE 14**

**Maximum vertical stress at CONSTANT INFLATION PRESSURE and various loads**





**Tyre Load = 20 kN**

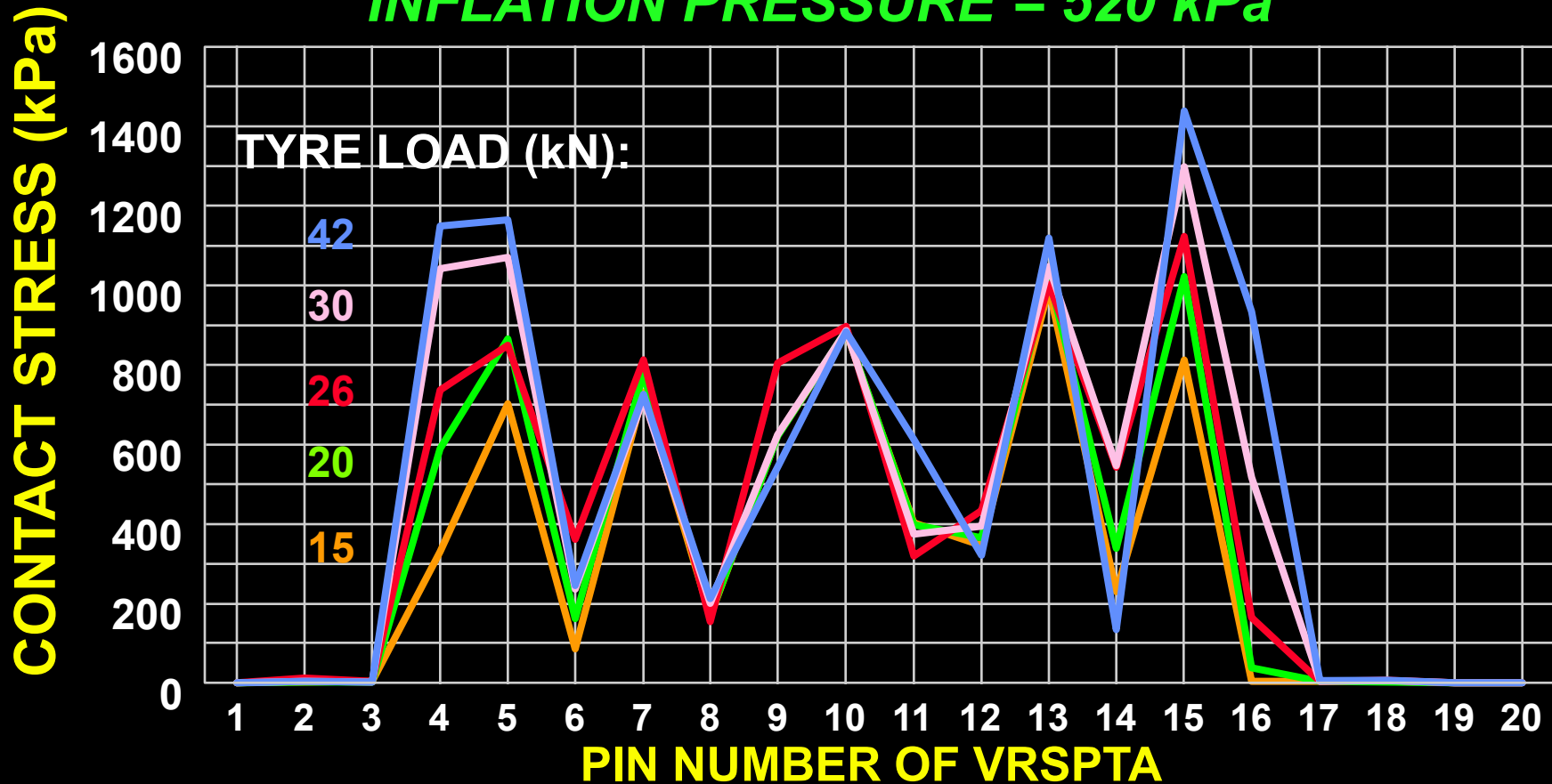


**FIGURE**

**Maximum vertical stress<sup>16</sup> of tyre with tread grooves at CONSTANT LOAD and various inflation pressures**



**INFLATION PRESSURE = 520 kPa**



**FIGURE 17**

**Vertical stress of tyre with tread grooves at CONSTANT INFLATION PRESSURE and various loads**

# 10.00 X 20 14 PLY TYRE WITH TREAD

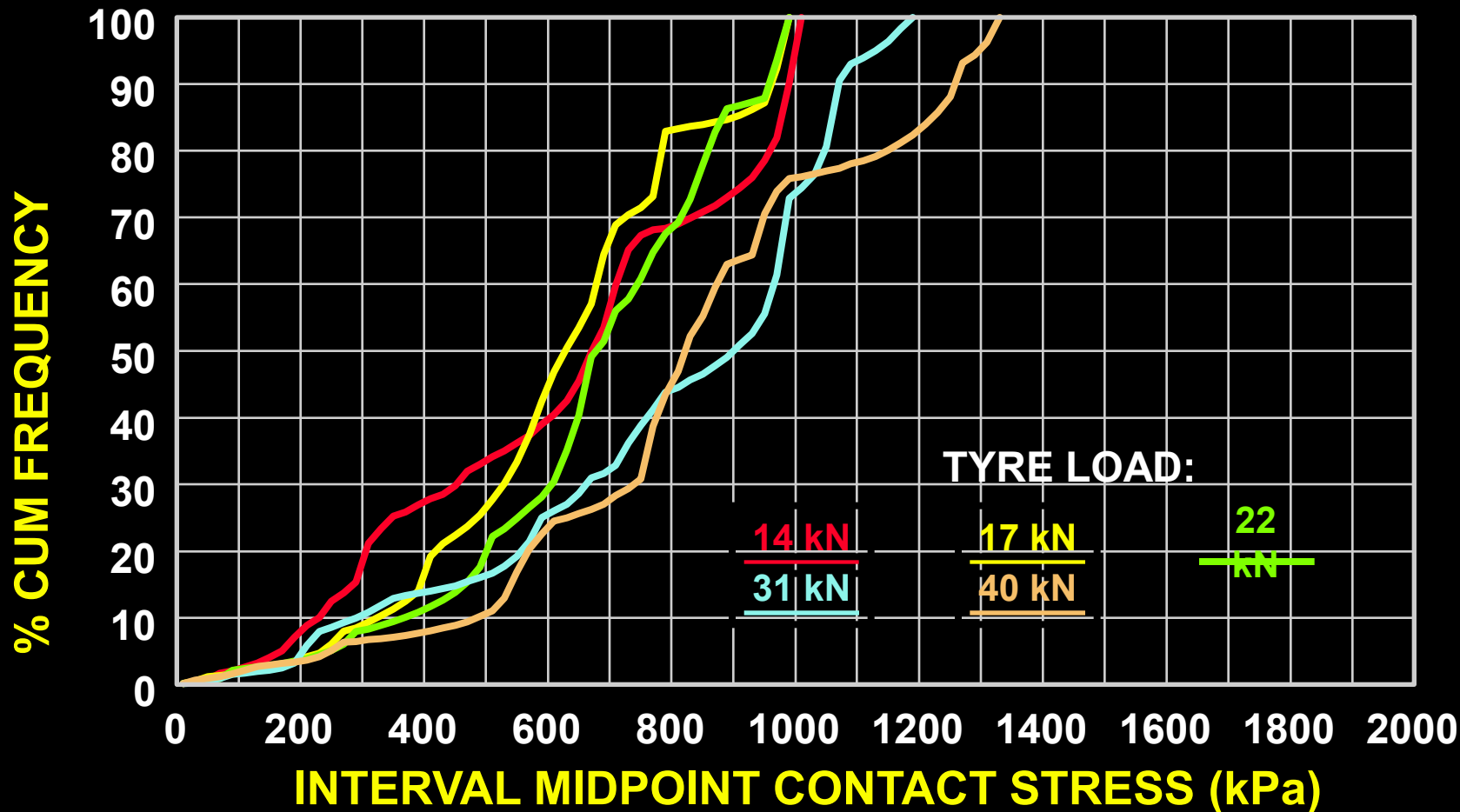
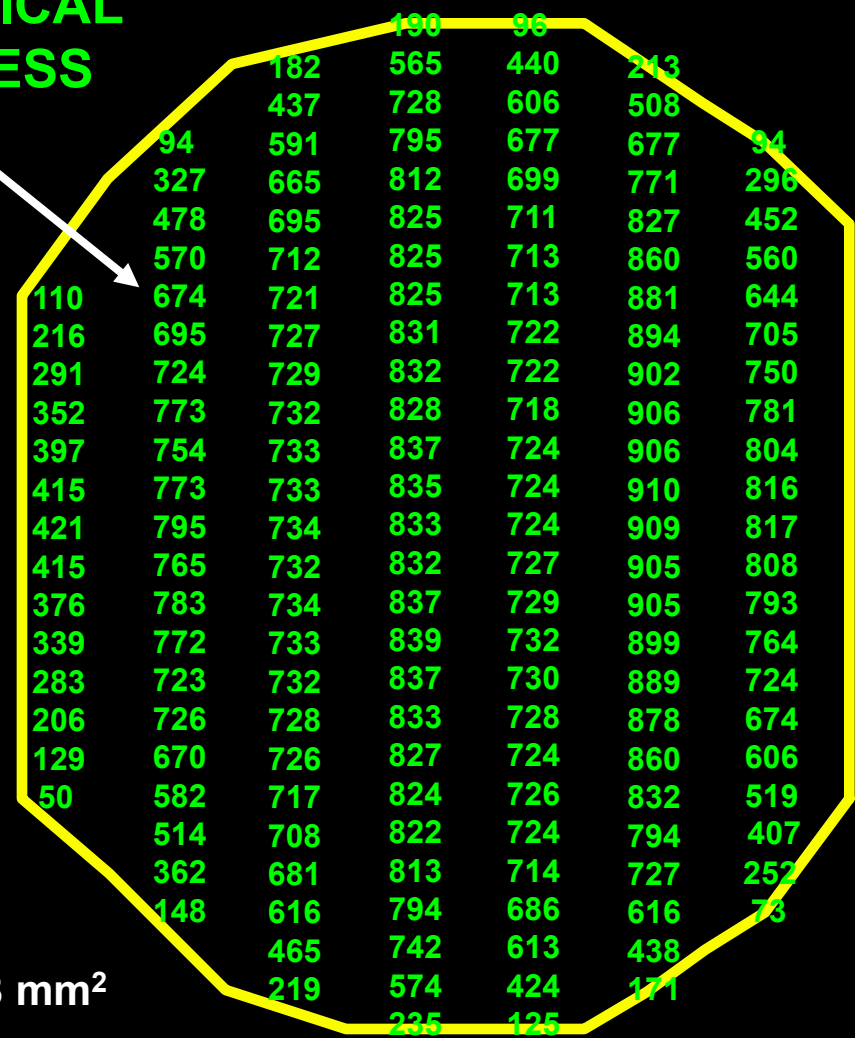


FIGURE 19

Cumulative frequency of maximum vertical stress



MEASURED VERTICAL CONTRACT STRESS VALUES



Patch area = 74 028 mm<sup>2</sup>

DIRECTION OF TRAVEL

FIGURE 25d

Typical measured tyre contact patch

# TYRE TYPE I (HVS SMOOTH) (11.00 X 20, 14 Ply)

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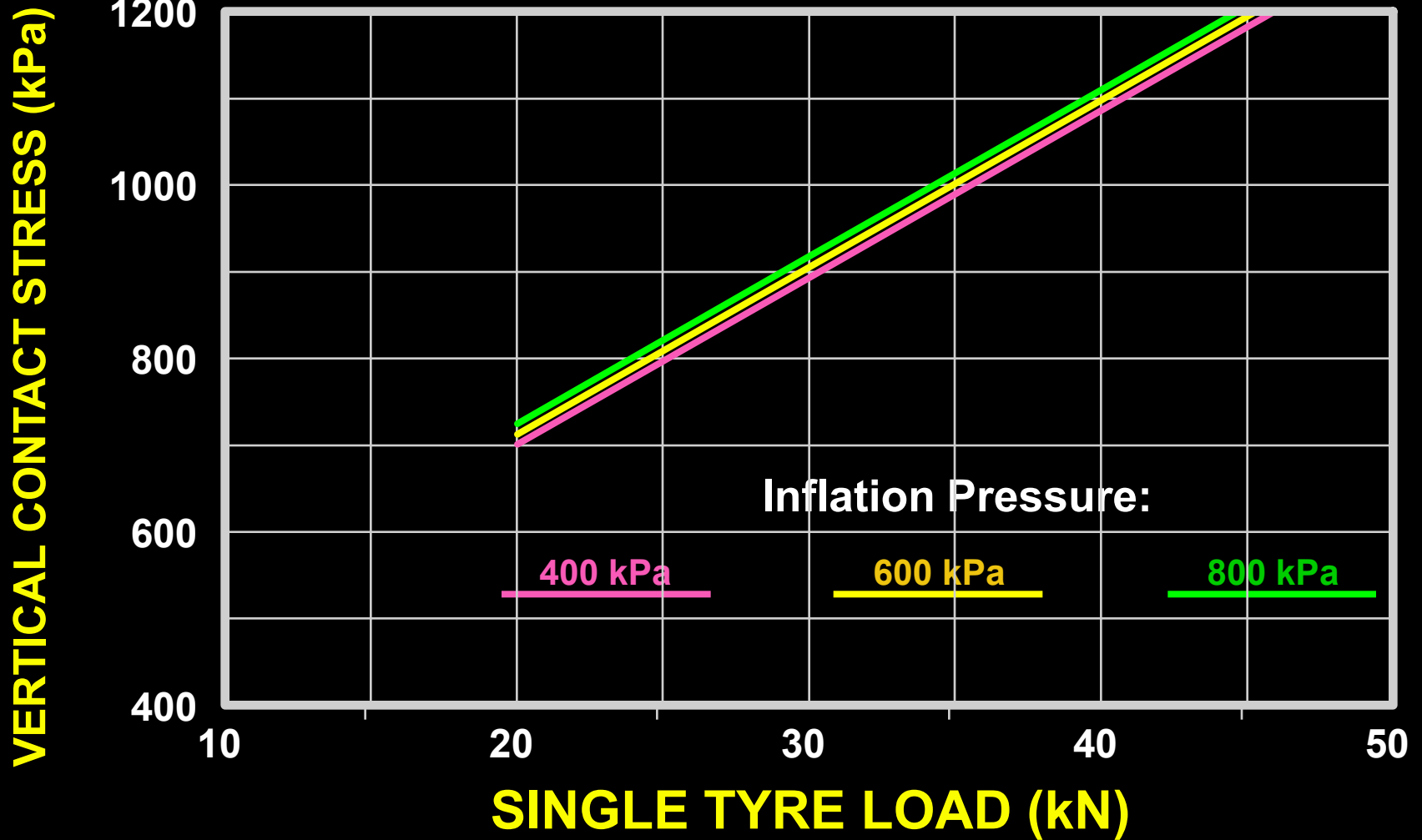


FIGURE 26a

Maximum vertical stress vs tyre load

# TYRE TYPE II (HVS - WITH TREAD) (11.00 X 20, 14 Ply)

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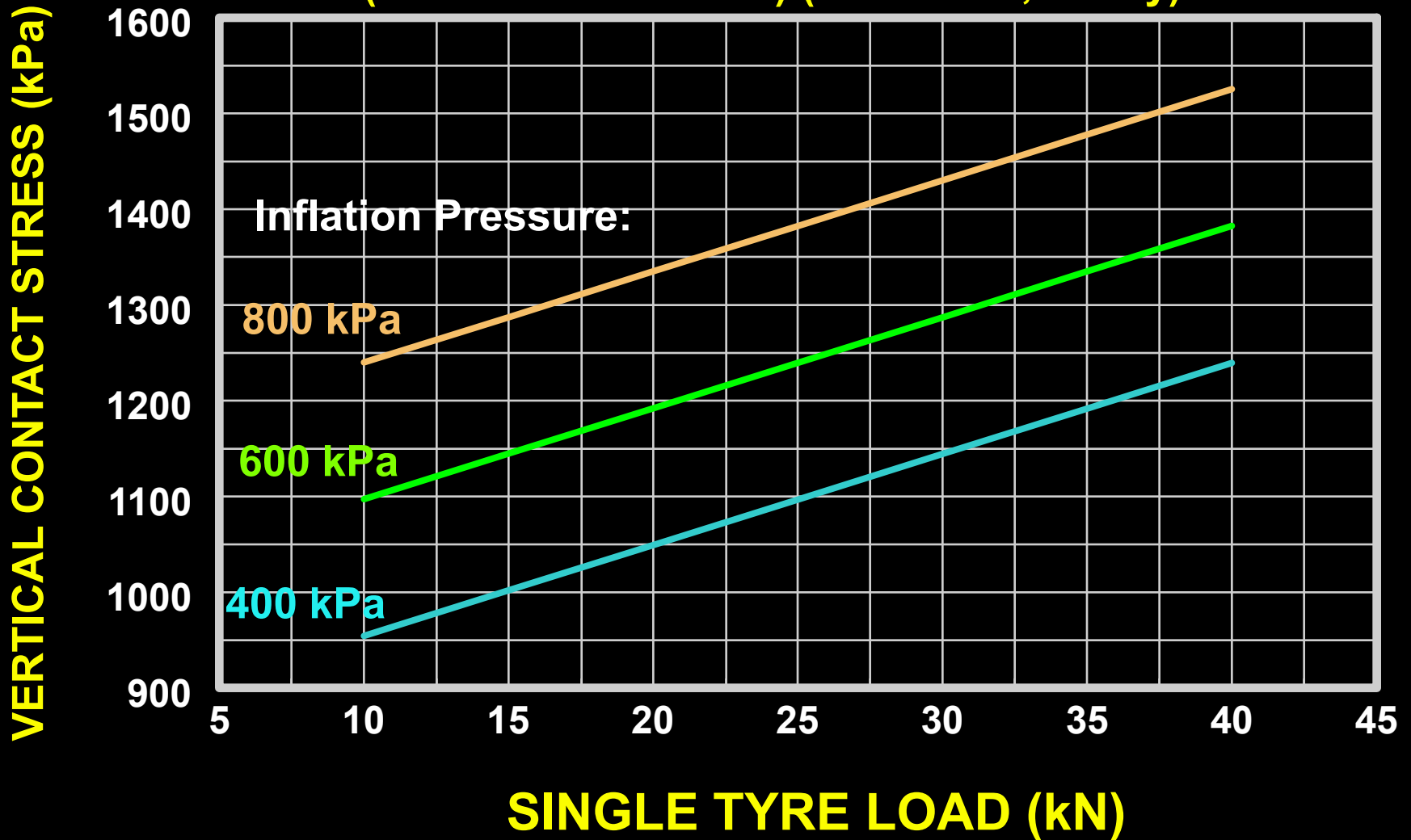


FIGURE 26b

Maximum vertical stress vs tyre load



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# TYRE TYPE III (AIRCRAFT TYRE)

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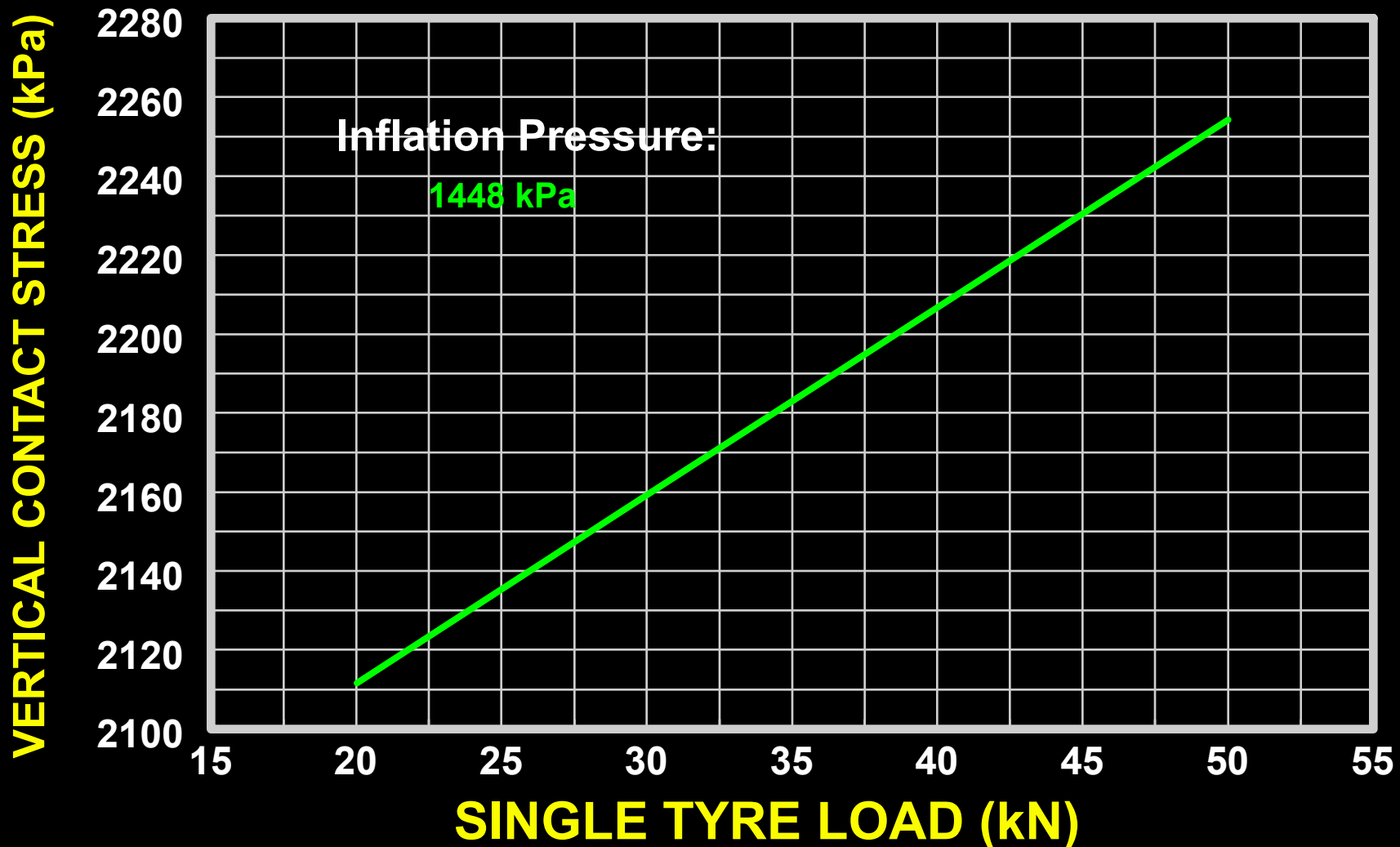


FIGURE 26c

Maximum vertical stress vs tyre load



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# TYRE TYPE IV (315/80 R22.5)

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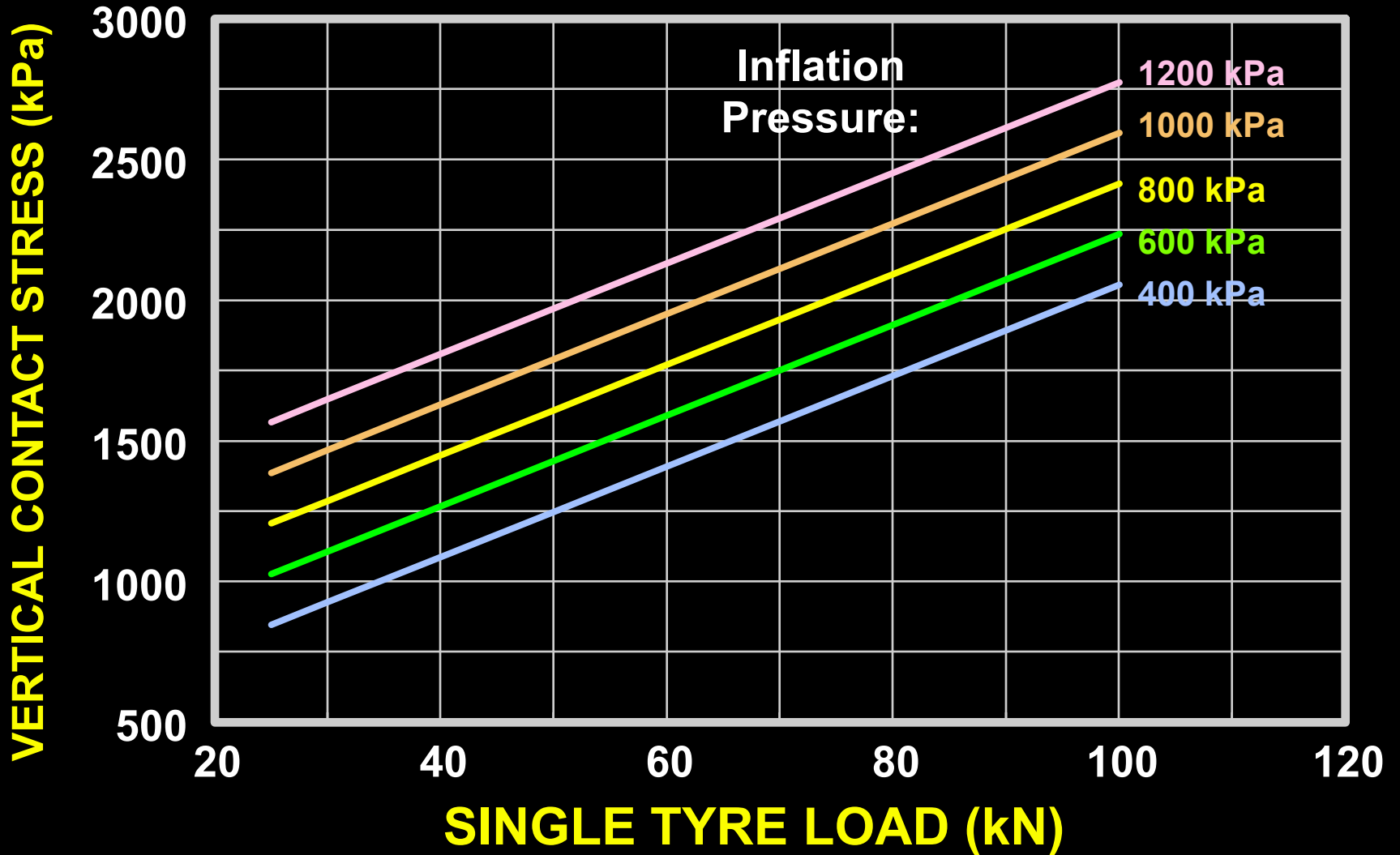


FIGURE 26d

**Maximum vertical stress vs tyre load**





### TYRE TYPE V (425/65 R22.5 - WIDE BASE)

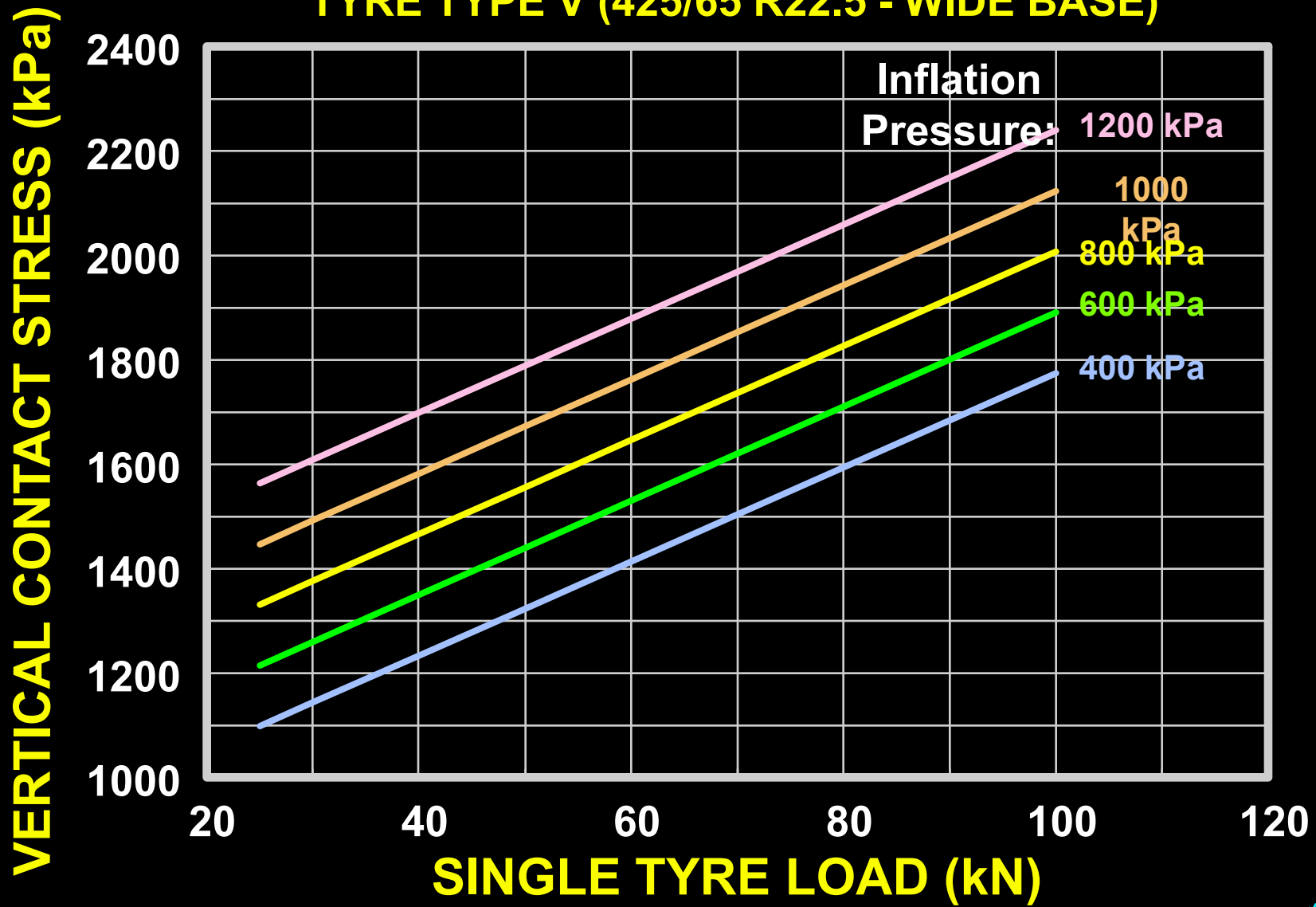
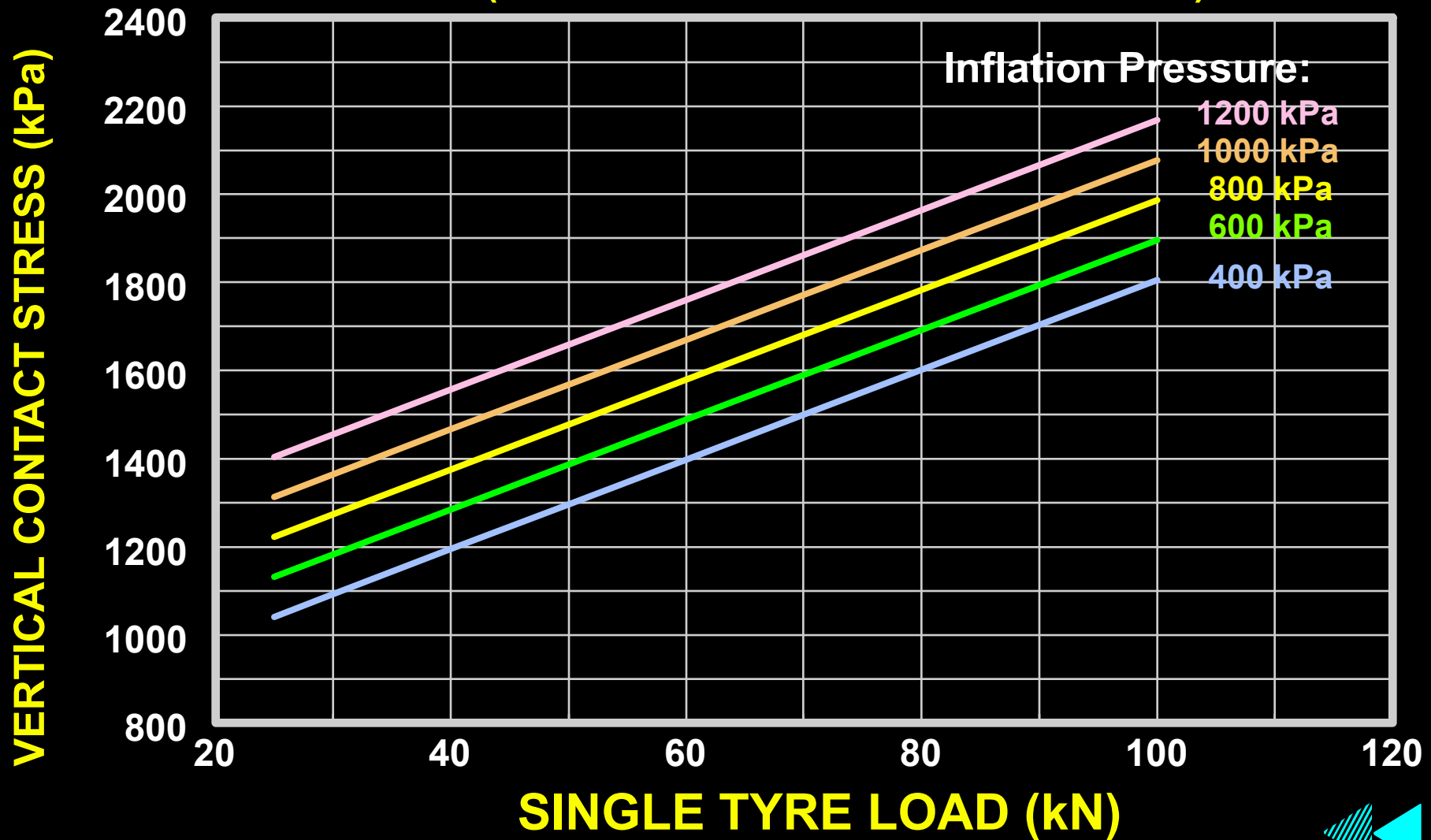


FIGURE 27a

### Maximum vertical stress vs tyre load



# TYRE TYPE VI (425/65 R22.5 - R160AZ WIDE BASE)



**SINGLE TYRE LOAD (kN)**

FIGURE 27b

**Maximum vertical stress vs tyre load**



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# TYRE TYPE VII (425/65 R22.5 - R160BZ - WIDE BASE)

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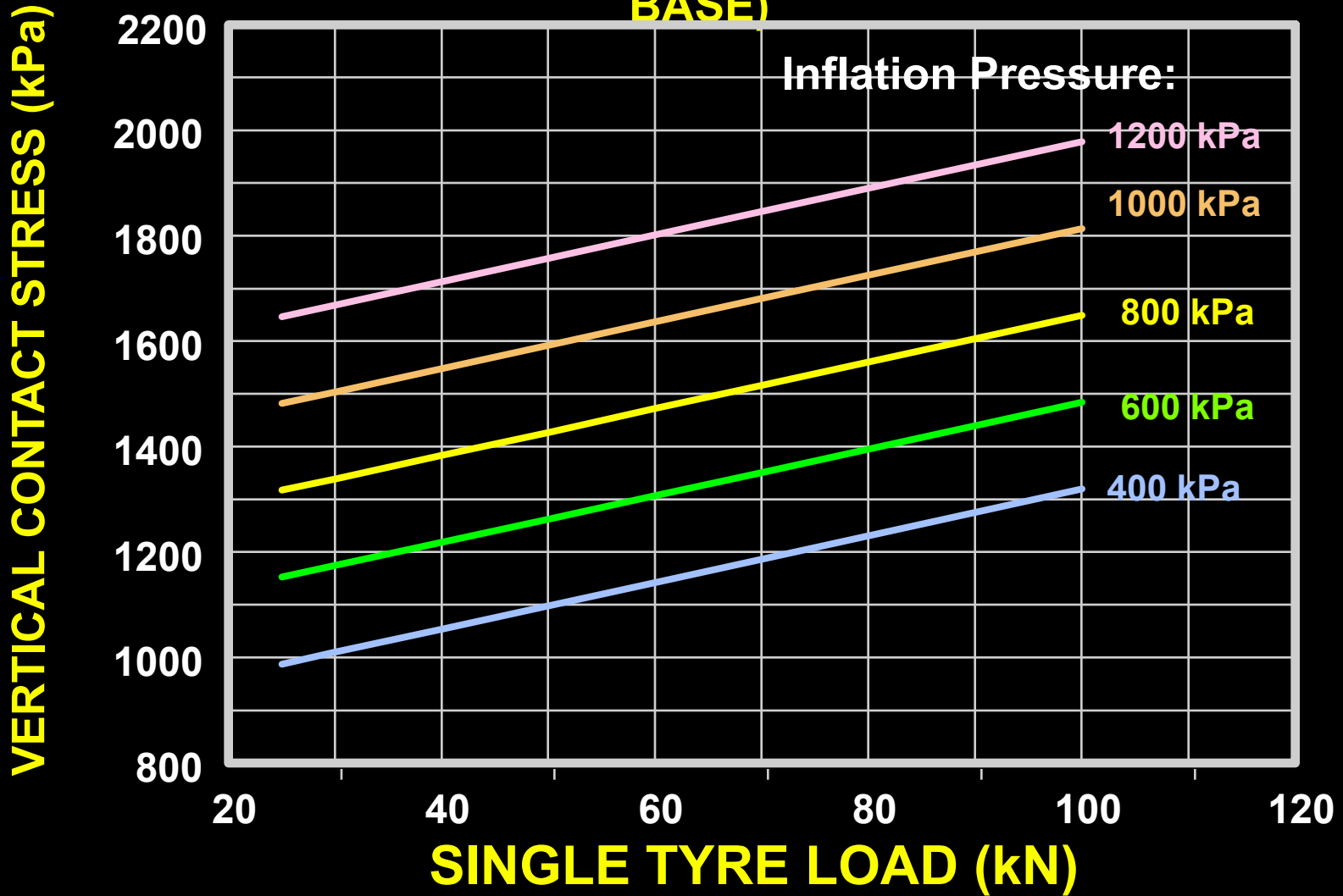


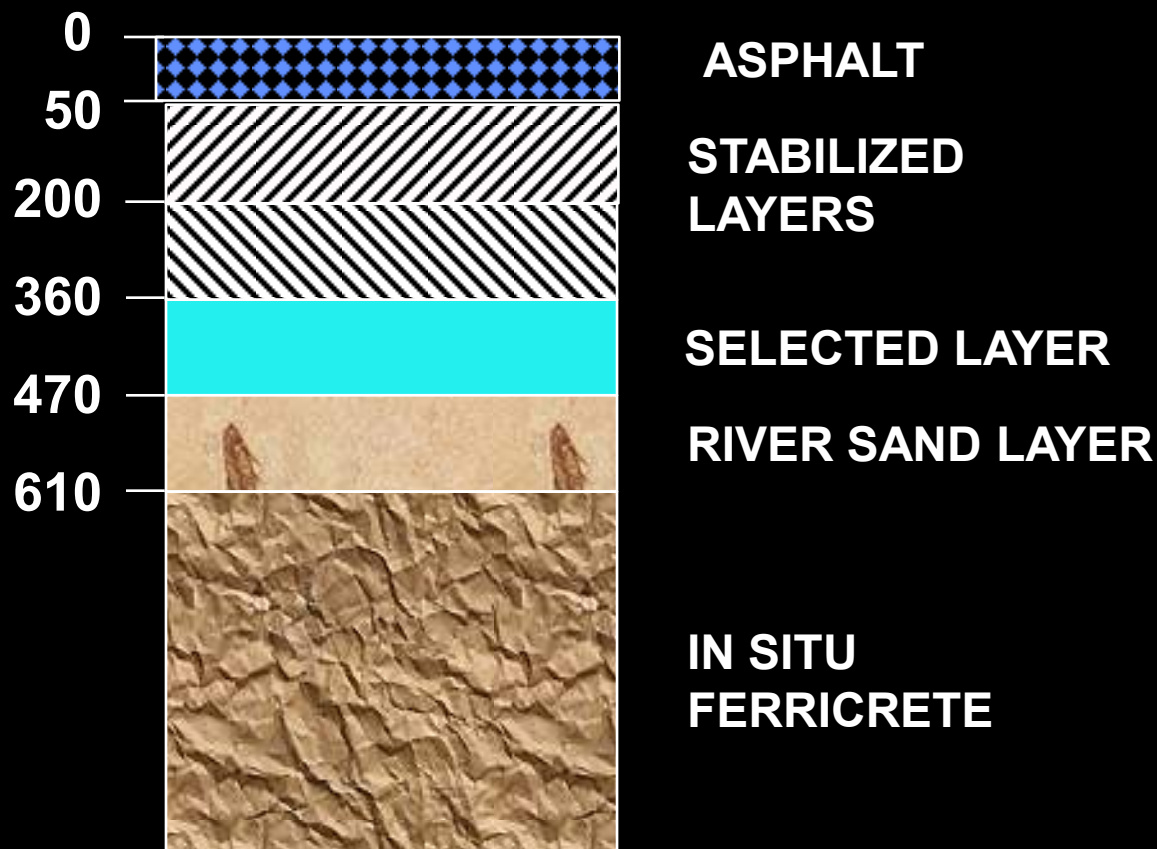
FIGURE 27c

Maximum vertical stress vs tyre load



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**DEPTH (mm)**



**FIGURE: 28**

**Pavement structures evaluated  
with the HVS**

Radial Distance (mm)

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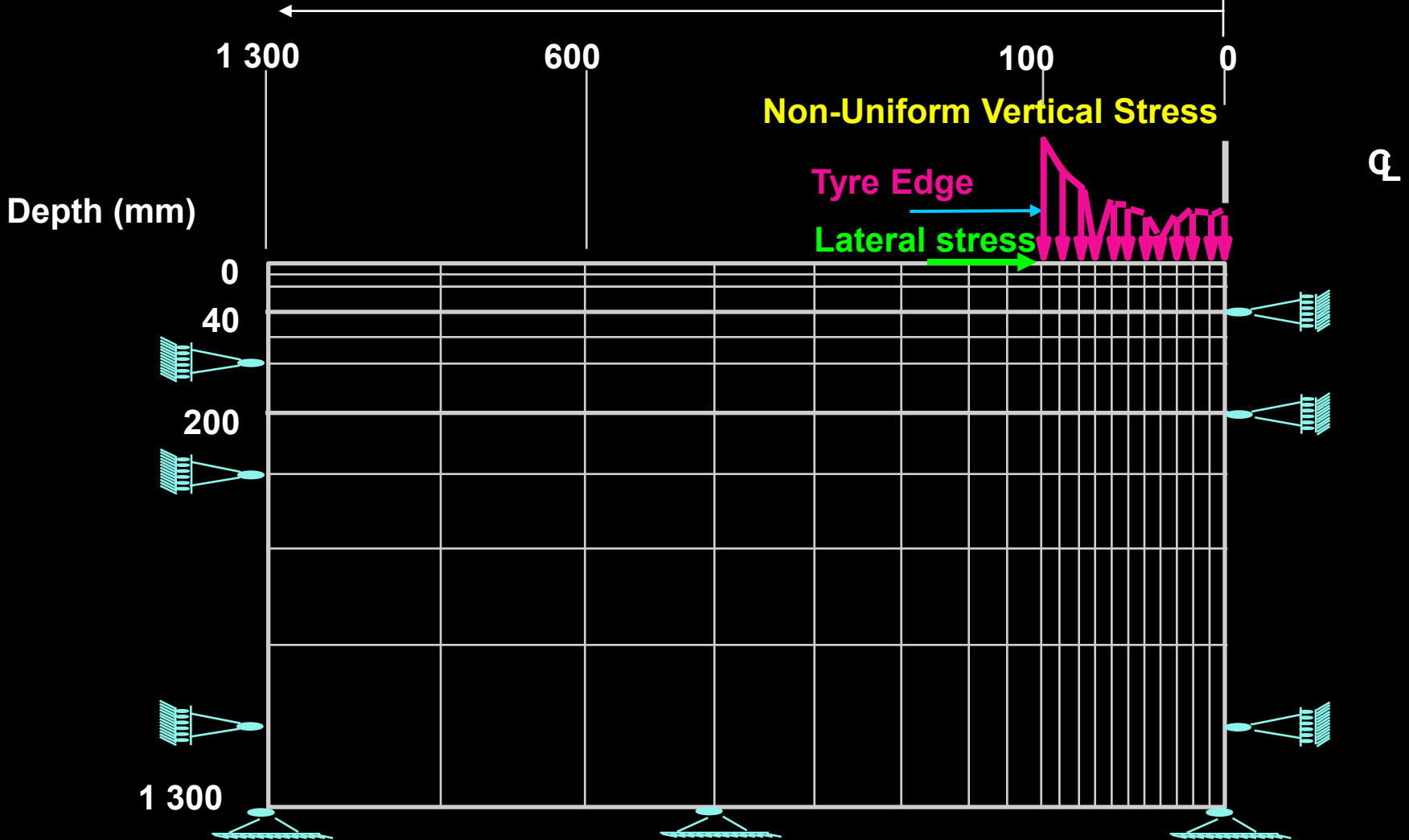


FIGURE: 29

**Axi-symmetrical Finite Element Model  
used in this study**



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TYPE

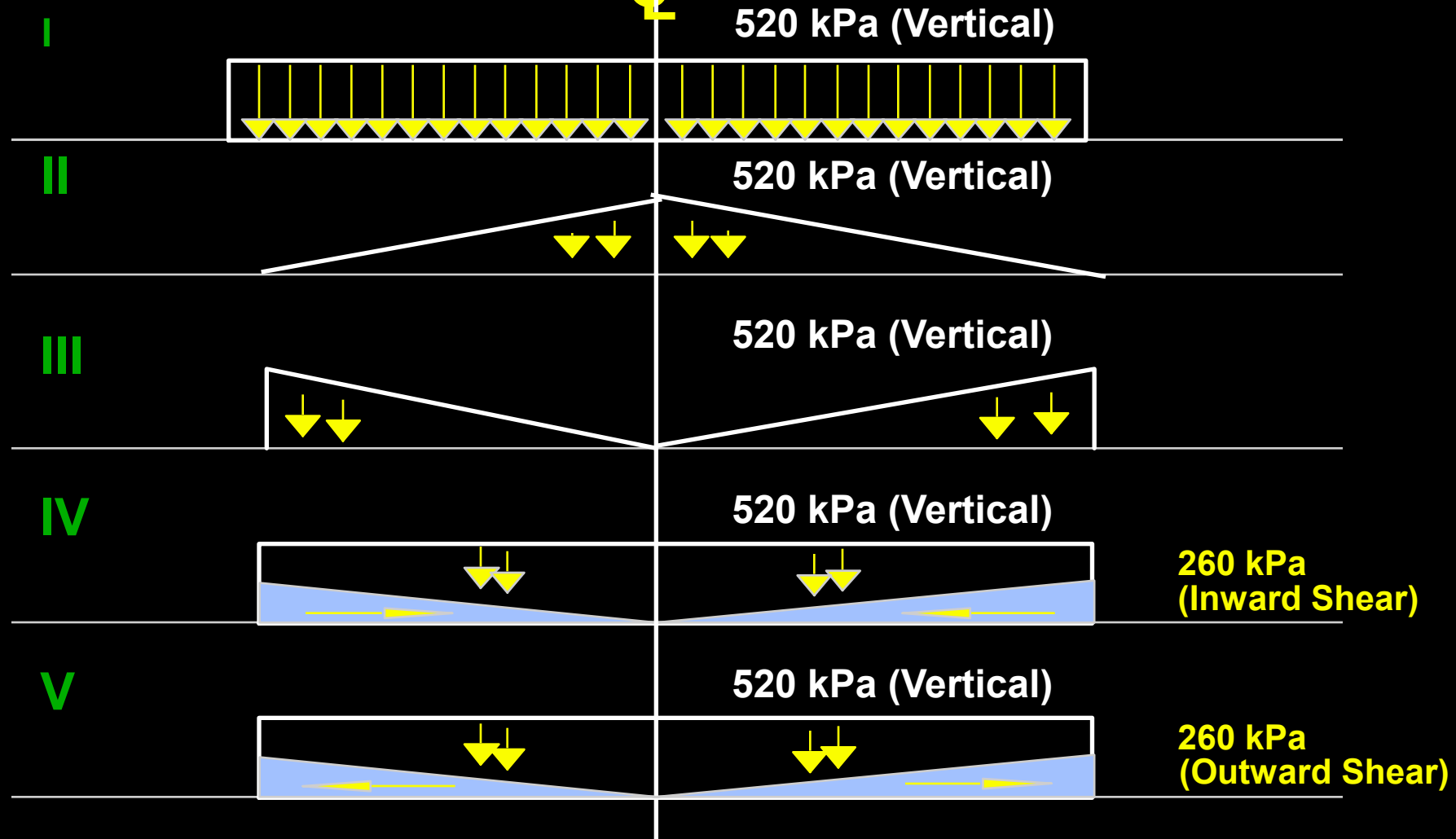
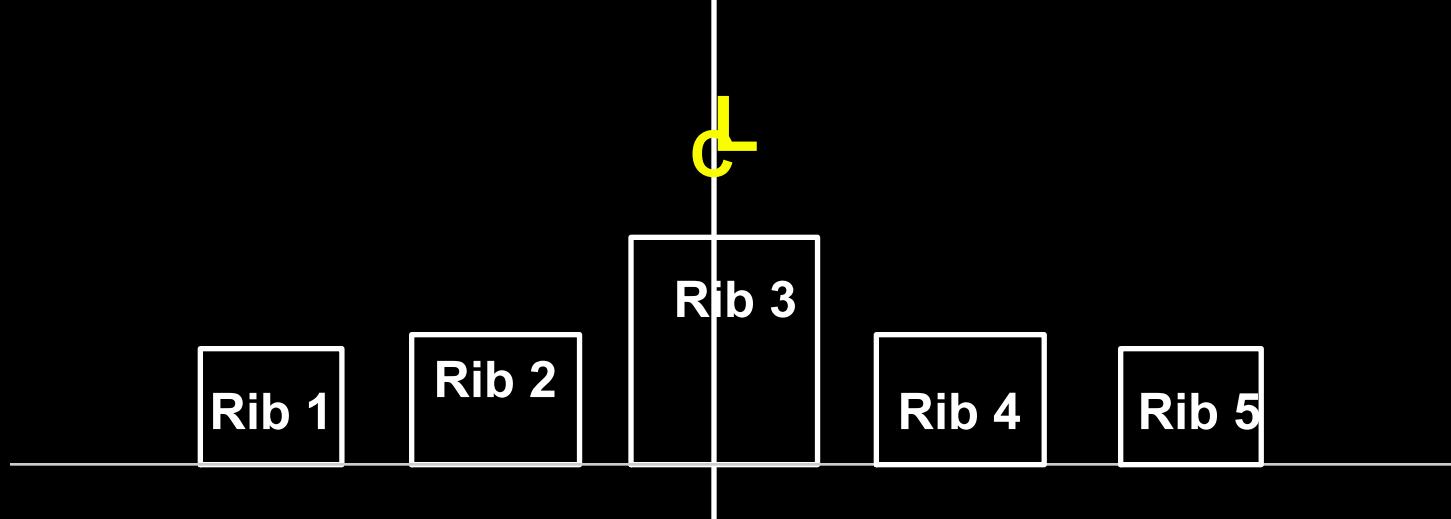


FIGURE: 30

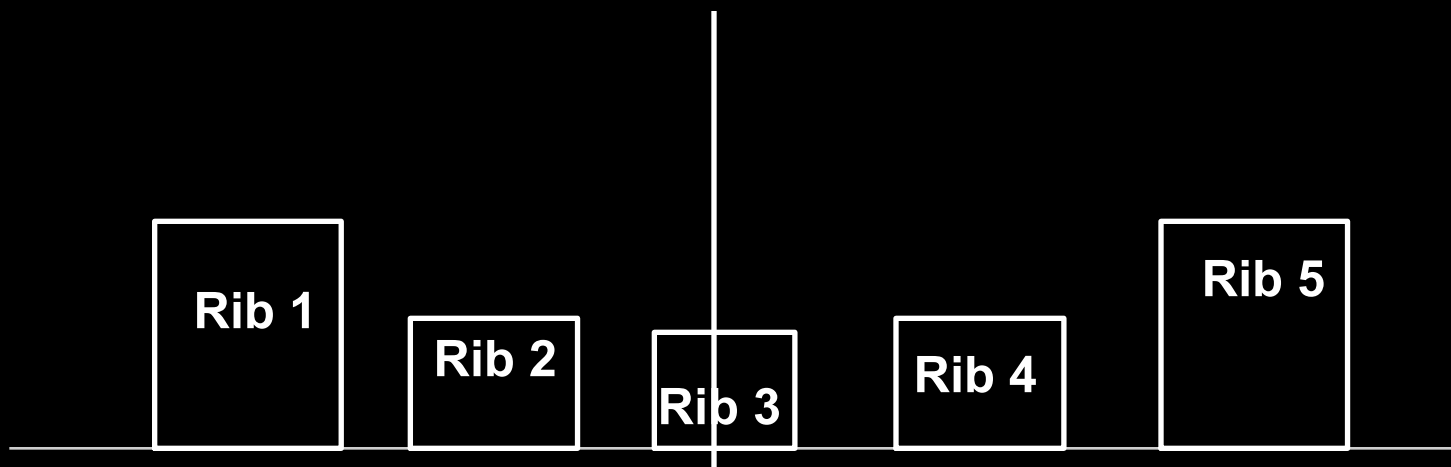
Load/Contact Stress Idealizations used for the analysis in this study



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**TYPE VI - TYRE CENTRE**  
(Vertical and lateral)



**TYPE VII - TYRE EDGE**  
(Vertical and lateral)



## **Maximum axle load legally allowed on South African Roads from 1996**

<b>Type of axle</b>	<b>No of tyres per axle</b>	<b>Axle Mass (kg)</b>	<b>Load per Axle (kN)*</b>
<b>Single axle (steering)</b>	<b>2 or 3</b>	<b>7 700 (7 700)</b>	<b>76</b>
<b>Single axle (non-steering)</b>	<b>2 or 3</b>	<b>8 000 (7 700)</b>	<b>78</b>
<b>Single axle</b>	<b>4 or more</b>	<b>9 000 (8 200)</b>	<b>88</b>
<b>Tandem axle</b>	<b>4 or more</b>	<b>18 000 (16 400)</b>	<b>88</b>
<b>Tridem axle</b>	<b>4 or more</b>	<b>24 000 (21 000)</b>	<b>78,3</b>

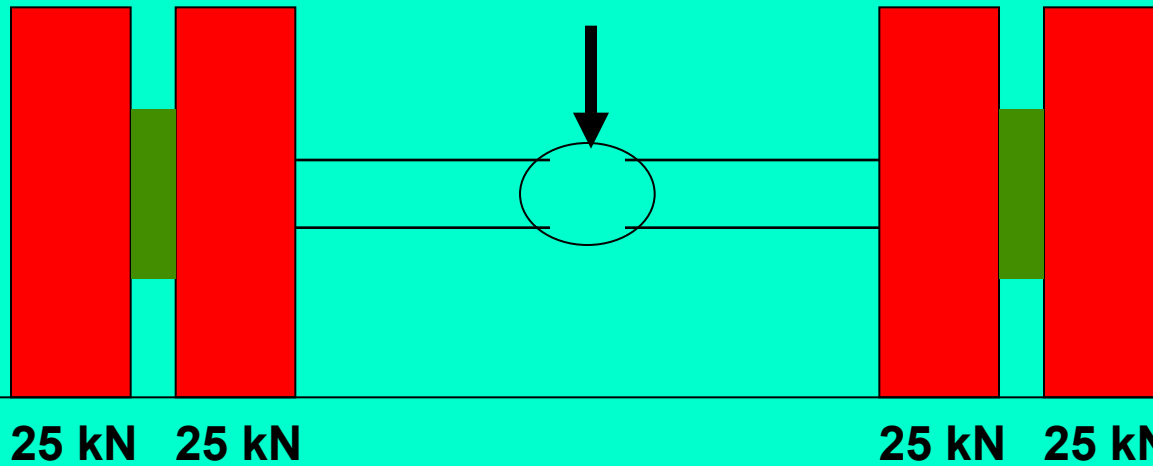
( ) Previous legal load limits

\*  $g = 9,8 \text{ m/s}^2$



**100 kN Axle**

**WHEEL  
LOAD**



**TYRE CONTACT STRESSES**

<b>Road Category [TRH4 (1996)]</b>	<b>Percentile Values (%)</b>	<b>Contact Stress (kPa)</b>	<b>Load Radius (mm)</b>
<b>D</b>	<b>50</b>	<b>660</b>	<b>110</b>
<b>C</b>	<b>80</b>	<b>865</b>	<b>96</b>
<b>D</b>	<b>90</b>	<b>975</b>	<b>90</b>
<b>A</b>	<b>95</b>	<b>985</b>	<b>90</b>

***Recommended new load/stress conditions  
for mechanistic analysis (RR 93/296)***