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Three dimensional contact stresses under the LINTRACK wide base single tyres, measured with the Vehicle-Road Surface Pressure Transducer Array (VRSPTA) system in South Africa

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Abstract: This report describes an international cooperative study into the 3 dimensional tyre/pavement contact stresses measured under *slow moving free rolling wide base single tyres* from the Netherlands. These tyres, a used tyre from the Dutch Lintrack system at TuDelft and a new tyre, were send to South Africa for a comprehensive set of contact stress measurements under the South African Heavy Vehicle Simulator (HVS), which was used to provide the loading and speed requirements needed for the stress testing. The vertical, transverse (or lateral) and longitudinal contact stresses between the tyres and the pavement were measured with the Vehicle-Road Surface Pressure Transducer (VRSPTA), developed in South Africa as part of the ongoing Accelerated Pavement Testing (APT) program with the HVS. This study consists mainly of a **raw data base** of various contact stress measurements from these tyres, together with a detailed description of the VRSPTA system used to perform the measurements.

A preliminary investigation of all the results grouped togehter indicated that the **average** ratios between maximum (peak) stress and the transverse (or lateral) stress are much lower than expected. The average ratio found between the **Vertical: Transverse: Longitudinal stresses** is: **10 : 1,5 : 1,0**. This is *much lower* than that found in similar studies on bias/cross ply tyres, which resulted in transverse stresses of up to 3 or 4 times than those found in the free rolling mode. However, when the data is divided into sub-groups the **maximum (peak)** stress ratios reached values up to **10 : 2,7 : 2,0.** It was also found that the transverse stress component of the wide base single tyres increased roughly 2,5 times under sideways shear compared to the free rolling case investigated here.

Although the measured stresses should be further analysed in more detail, a very tentative observation is that owing to the ***relatively low peak transverse stresses found*** for the two tyres tested in the different modes *it is doubtful whether this component alone could be responsible for the development of large enough transverse tensile strains close to the tyre edge which may lead to longitudinal fatigue cracking starting at the surface of the asphalt layers in the Netherlands.* The total 3-D stress conditions should, however, be used in a thorough pavement analysis in order to study the problem of load/stress associated longitudinal cracking (from the surface) in greater detail.

Keywords: Measured contact stresses, wide base single tyres, Vehicle-Surface Pressure Transducer Array (VRSPTA), Lintrack, Heavy Vehicle Simulator (HVS)

Proposals for implementation:
Integration by means of further data analyses with existing Accelerated Pavement Testing (APT) research programs in The Netherlands and South Africa, or elsewhere.

Related documents (eg software, interim or other reports, working drawings etc):
Measured data available on eight (8) diskettes in zipped format, and are listed in the Appendices.

Signatures:

Language editor	Dr S V Kekwick Technical Reviewer	F C Rust Programme Manager	A van der Merwe Info Centre

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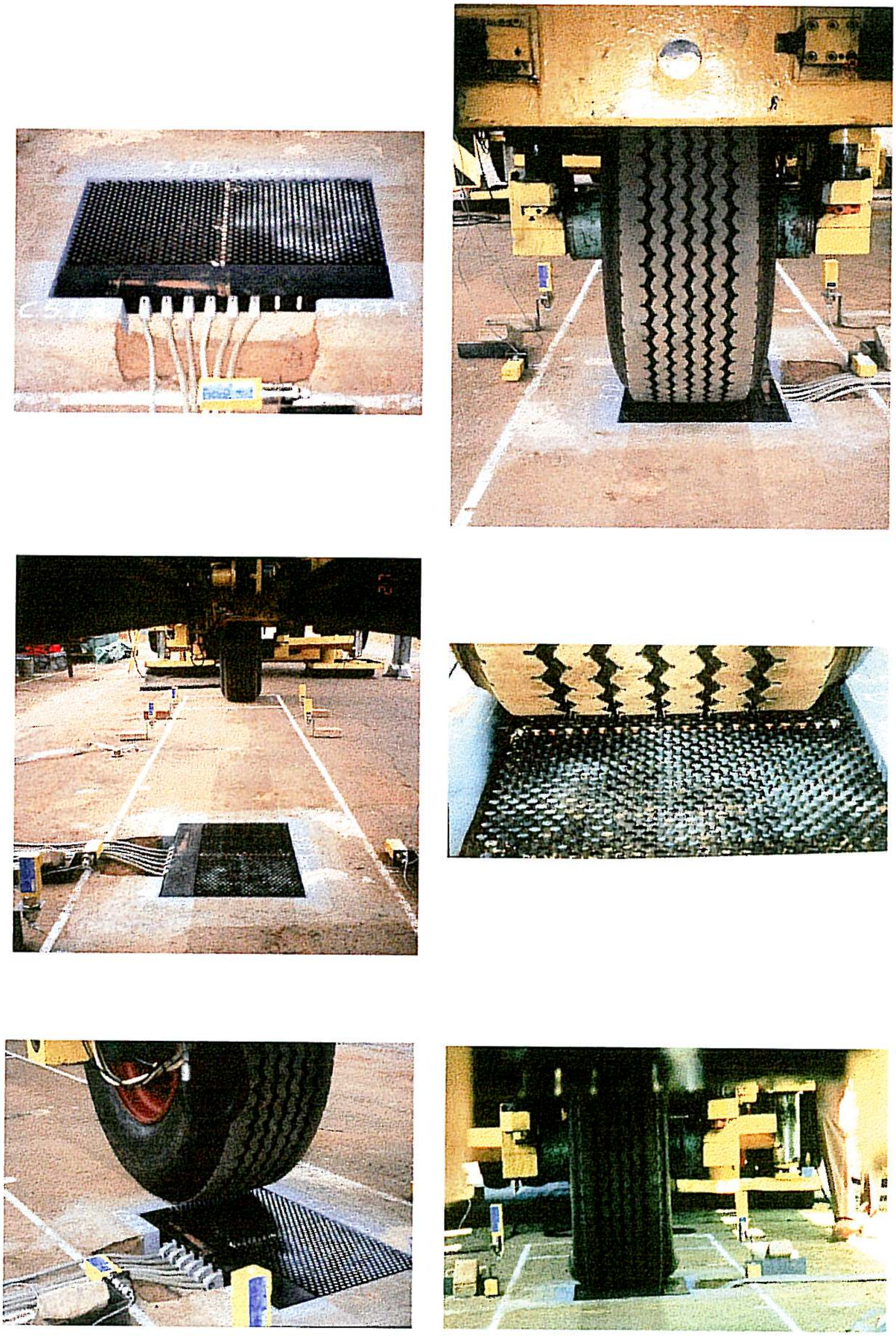

Plate 1 : Images of the Vehicle-Road Surface Pressure Transduser Array (VRSPTA) as used under the Heavy Vehicle Simulator (HVS). The tyre tested here is a wide base 425/65 R 22.5 type.

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The Road and Hydraulic Engineering Division (RHED) of the Dutch Ministry of Transport, Public Works and Water Management and Gautrans, the Roads Department of the Province of Gauteng in South Africa, are gratefully acknowledged for their sponsorship of the research measurements given in this report.

Prof A A A Molenaar of the Road and Railroad Research Laboratory of the Delft University of Technology (RRRL, TUDELFT), The Netherlands, is thanked for his motivation and support with this cooperative international contract research project.

The Director of the Division of Roads and Transport Technology, a Division of the Council for Scientific and Industrial Research (CSIR) in South Africa is also thanked for his support during this contract.

The measurements were made using the advanced Vehicle-Road Surface Pressure Transducer Array (VRSPTA) system, developed between 1991-1995 by the Division of Roads and Transport Technology, CSIR, Pretoria, South Africa [De Beer, 1995a]. To apply a moving wheel load over the VRSPTA system, the Heavy Vehicle Simulator (HVS) system was used (HVS04, owned by the Gauteng Roads Department, Gautrans). See Plate 1. The HVS was developed 1970-1978 by CSIR, Division of Roads and Transport Technology (the then National Institute for Transport and Road Research, NITRR, in South Africa) and is extensively described elsewhere [Walker et al, 1977; Freeme et al, 1981; Maree, et al, 1982; Freeme et al, 1982a; Freeme et al, 1982b; Freeme et al, 1984; Freeme et al, 1987; De Beer et al, 1987; De Beer et al, 1988; De Beer, 1991; Horak et al, 1992].

The measurements discussed in this report were executed in the period June/July 1996, on the HVS site on Secondary Road S702 near Bultfontein, approximately 40 km north of Pretoria, in the Gauteng Province in South Africa.

PREFACE

The information contained in this report is a direct result of quantitative measurements that were made using a Vehicle-Road Surface Pressure Transducer Array (VRSPTA). The results obtained from the VRSPTA are presented here in the form of three dimensional (3-D) stresses occurring between relatively slow moving free-rolling wide base single radial tyres and the road (pavement) surface. The research measurements were done with the aid of the Heavy Vehicle Simulator (HVS), in South Africa, on which two LINTRACK test tyres were fitted (one old tyre and one new tyre). Various load/inflation pressure and speed combinations were then applied with the moving wheel over the VRSPTA system.

The information given here is considered a vital step in the search for improved quantification and characterization of the various main contact stresses acting between moving pneumatic tyres and the surface of the pavement to serve as inputs towards enhanced analysis of the behaviour of, especially, flexible pavement structures.

This project was done in cooperation with the Road and Hydraulic Engineering Division (RHED) of the Dutch Ministry of Transport, Public Works and Water Management, as well as Gautrans, the Roads Department of the Province of Gauteng in South Africa. The research was directed by both the Road and Railroad Research Laboratory of the Delft University of Technology (RRRL, TUDELFT) and the Division of Roads and Transport Technology, a Division of the Council for Scientific and Industrial Research (CSIR), in South Africa.

All reasonable care was taken in doing the measurements given in this report and the results were checked for possible errors. However, no responsibility can be accepted for the consequences of any inaccuracy which may be contained in the use and application of the results given. Both the Transportek of the CSIR, and RRRL, make no claims and do not assume responsibility for correcting all errors; nor can either be held responsible for any damages which may be incurred as a result of the application of the results given.

The views expressed in this publication are those of the authors and do not necessarily reflect those of the Delft University of Technology in The Netherlands, or the Division of Roads and Transport Technology of the CSIR in South Africa.

Any person wishing to make use of the results presented in this report is invited to do so. The only restriction that is imposed on such use is the full and correct citation of the findings, after permission is granted to use the information given.

As the *aim* of this report is to act as a ***raw database*** of various contact stress measurements done under the Lintrack tyres, no detailed further analysis or interpretation of the data given here was attempted, other than a summary of the *stress ratios*, based on the maximum (peak) stresses in three directions obtained from the various tests done.

Some general observations from the results following from this study are made at the end of this report.

These stress RATIOS are given in the following format, based on the convention[1] proposed by Timoshenko et al (1970), with the exception here that compression in the z-direction is considered positive (+):

Vertical Stress (σ_{zz}) : Transverse (or Lateral) Stress (τ_{zy}): Longitudinal Stress (τ_{zx}),

and are discussed in more detail later.

1 The first subscript indicates the direction of the normal to the plane under consideration and the second indicates the direction of the component of stress.

1. INTRODUCTION

Since the late 1960s it has been common practice to assume a uniform circular vertical contact stress (generally equal to or somewhat *lower* than the tyre inflation pressure) for modelling the tyre/pavement interface stress condition on both flexible and rigid pavements. Although a wealth of information already exists to prove that the vertical stress components at the moving tyre/pavement interface are not uniformly distributed and that some shear stresses are also present, both in the lateral (or transverse) direction as well as the longitudinal direction, it remains difficult to quantify accurately these stresses under moving truck tyres. In addition, it is difficult to model multi-layered pavements taking these non-uniform contact stress distributions into full consideration.

However, because of ongoing changes and improvements in the design and performance of pneumatic tyres, these stresses may also change and it is therefore of paramount importance to quantify them correctly for the purposes of effective pavement design and evaluation. The change from bias ply (cross ply) to wide base radial ply tyres has resulted in different tyre contact stresses, as well as in a more square tyre contact area in contrast to the more circular or elliptical shapes found under loaded bias /cross ply tyres. Some discussion of the different tyre contact stresses found for wide base radial tyres is given in Section 9 . The shape of the contact area and the distribution of the contact stresses are, however, strongly dependent on the type of tyre, the load, the inflation pressure and the evenness (or unevenness) of the surface upon which the tyre is acting under load.

This report concentrates on the measurements of the three dimensional (3-D) tyre/pavement contact stress distributions under two wide base single pneumatic radial type tyres used for Accelerated Pavement Testing (APT) in the Netherlands on the LINTRACK system at TUDELFT. The 3-D contact stress measurements were conducted with the Vehicle-Road Surface Pressure Transducer Array (VRSPTA) system that was developed in South Africa for use with Accelerated Pavement Testing (APT) with the South African Heavy Vehicle Simulator (HVS), as part of the Division of Roads and Transport Technology's APT programme.

The VRSPTA system used here is the second prototype system, and incorporates some improvements relative to the first system developed during 1992/3 and which is reported on elsewhere [De Beer, 1994]. This system was developed to prove the concept of the measurements of the 3-D stress components at the moving tyre/pavement interface. The stresses that are measured simultaneously are:

- The Vertical contact stress *positive* in the Z - direction, σ_{zz};
- The Lateral (or Transverse) shear stress across the contact area *positive* in the Y - direction (ie from pin 1 *to* pin 21 on the VRSPTA), τ_{zy}, and the
- Longitudinal shear stress, τ_{zx} (*Positive* in the X - direction, ie in the direction of the moving wheel).

The first prototype VRSPTA suffered inaccuracies of up to 25 percent concerning the total load measured after integration of the vertical stress volume [De Beer, 1994], but this was largely corrected by improvements to the design of the current (advanced) VRSPTA system used for the measurements given in this report [De Beer 1995a, 1995b].

2. DESCRIPTION OF THE IMPROVED VRSPTA SYSTEM

The advanced VRSPTA system (commonly known as the "3-D Stress Sensor" or "3-D Load cell") consists of 1041 flat topped cone shaped hollow steel pins mounted in 51 rows on a steel base plate. Twenty (20) pins in the centre row (array) of 21 pins are instrumented with strain gauges, thus forming 20 small individual tri-axial load cells transversely distributed across the base plate.

The VRSPTA is set in a steel pan embedded in the pavement such that the VRSPTA surface is flush with the pavement surface. The basic principle of the VRSPTA is that the loads on each tri-axial strain gauged load cell pin across the tyre contact patch are measured directly from which the contact stresses imposed on the road (or in this case the VRSPTA surface), are then calculated during post-processing of the data. The vertical, transverse (or lateral) and longitudinal forces (loads) are therefore measured in one line across the tyre contact patch in real time by the array of instrumented pins. The rolling wheel load is moved across the instrumented pins, thus enabling the loads to be measured in time fragments until the total contact area has traversed the load cell. The remainder of the pins (all of equal geometric shape and height, approximately 50 mm) are supporting pins of the same shape, contact area and all-direction stiffness (rigidity) as the instrumented pins.

There are 60 active channels (20 pins x 3 directions) which simultaneously scan all the strain gauges when the wheel moves over the array of instrumented pins in the centre portion of the load cell. Data acquisition is automatically triggered by coaxial cables and/or optical beams on the approach side of the load cell. Separate micro switches on both sides of the load cell in the longitudinal direction serve to measure the speed of the moving wheel across the instrumented pins.
The current VRSPTA system is considered adequate for research purposes, especially with Accelerated Pavement Testing (APT) devices. It can potentially be used as a "Stress-In-Motion" (SIM) system on highways, especially at weighbridge stations, but needs further improvements to be more user and production friendly for use as a potential replacement for current "Weigh-In-Motion" (WIM) systems.

A schematic layout of the VRSPTA is given in Figures 1 and 2.

The electronic system consists of two major components:

- Topward Laboratory Power supply (TPS-4000), capable of supplying 20V at four (4) Amps, and

- a rack of strain gauge conditioners with excitation voltage of 7,0 volts for the vertical gauges (Z) and 3,5 volt for the horizontal gauges (X,Y). The cut off frequency is 1 kHz and gain set at 1000 times.

The current Data Acquisition System (DAS) consists of four 386SX computers, four PC30 DS A-D (Analog to Digital) cards and the DAS software. One computer is used as the "master". This has a VGA screen and a large hard disk, is able to run the software and controls the three other slave computers. These slave computers serve mainly as a housing for the A-D cards. The DAS software produces three files, one for the results of each load direction (Y = Transverse (or Lateral), X = Longitudinal, Z = Vertical). In each file, the data are arranged in a table format, with a column for each measuring channel.

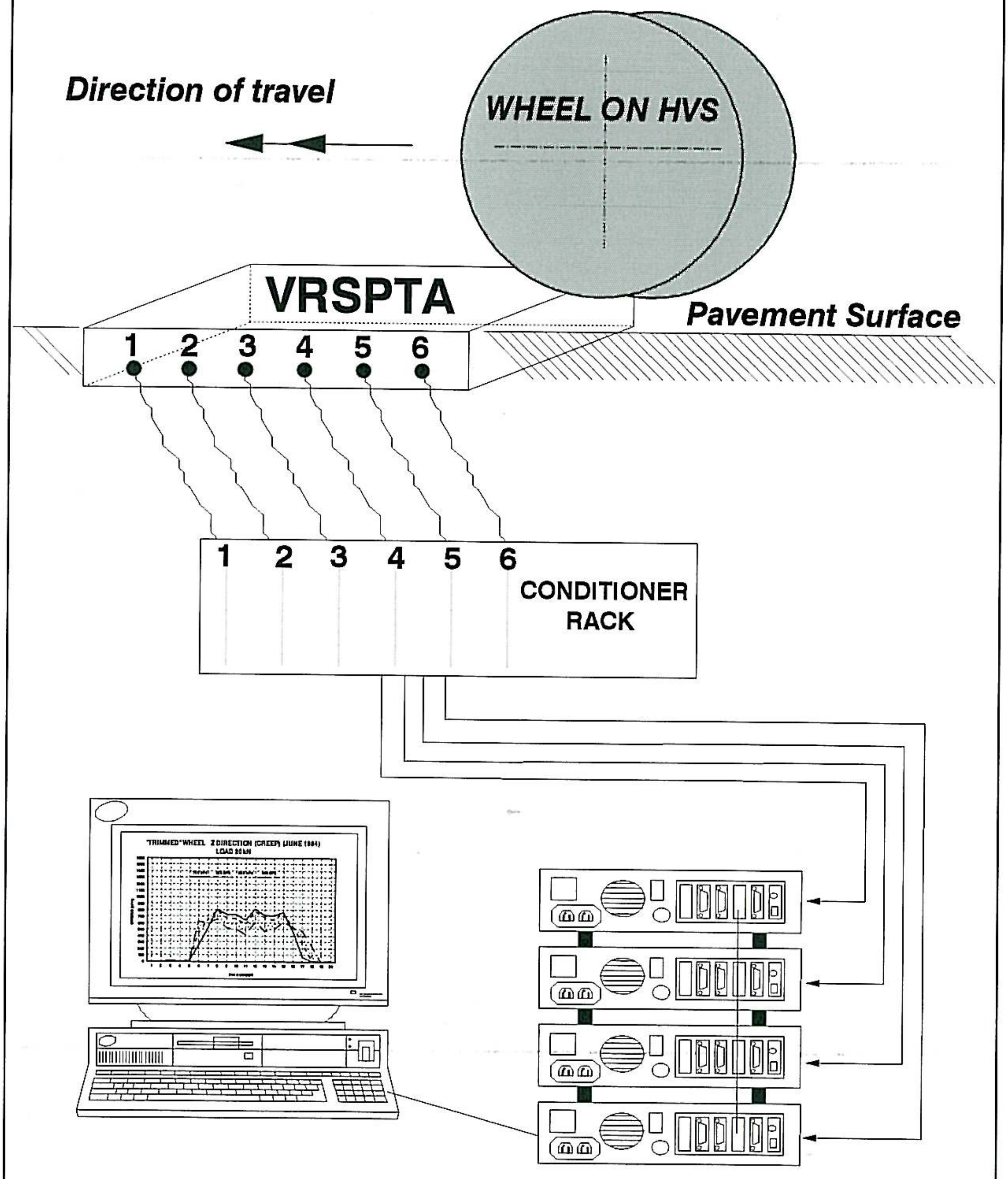

FIGURE 1
LAYOUT OF THE VEHICLE-ROAD SURFACE PRESSURE TRANSDUCER ARRAY (VRSPTA) SYSTEM

C:\TUDELFT\FIGURE1.DRW

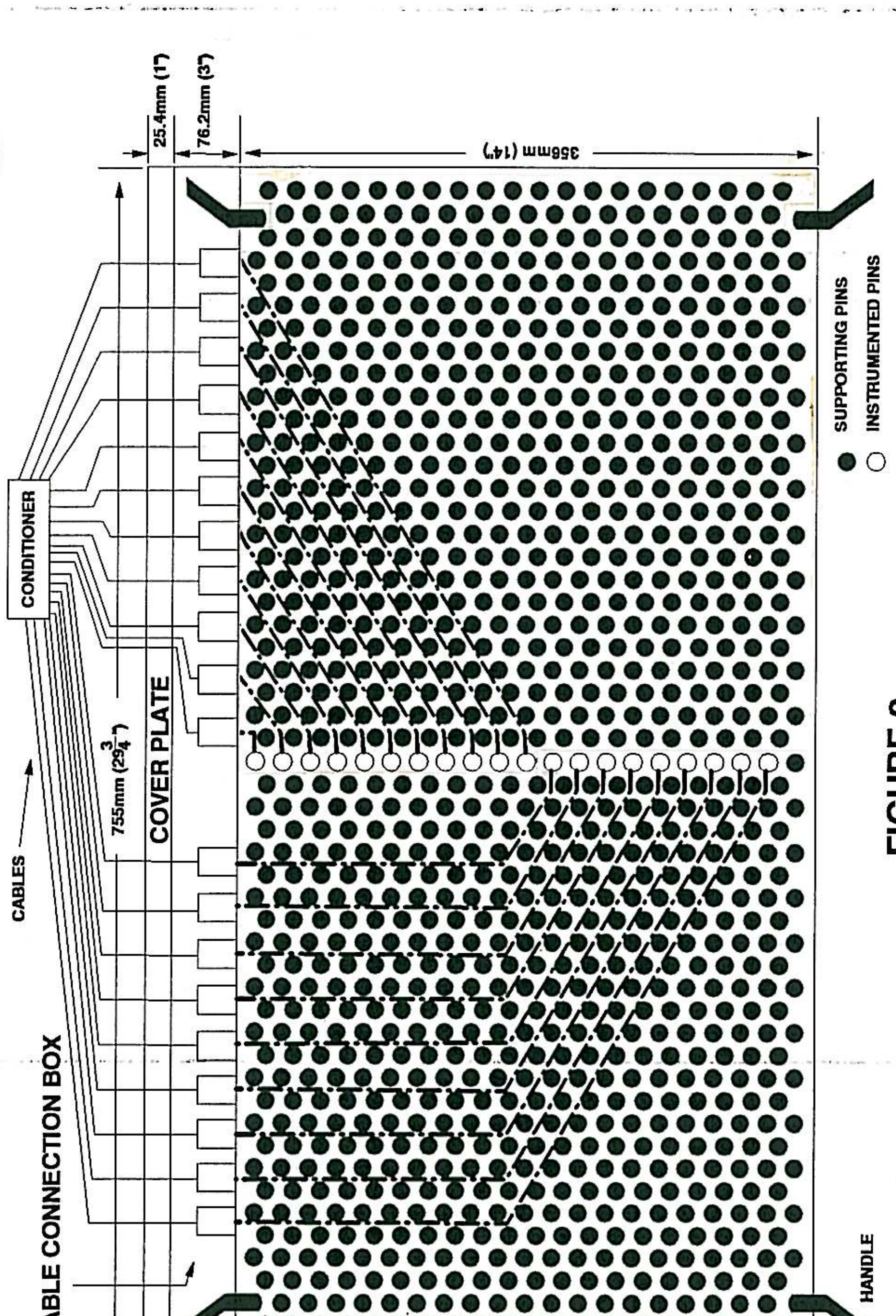

FIGURE 2

TOP VIEW OF THE VEHICLE-ROAD SURFACE PRESSURE TRANSDUCER ARRAY (VRSPTA)

C:\TUDELFT\FIGURE2.DRW

A maximum sampling rate of up to 12,5 kHz per channel is possible with the current system. However, at a wheel speed of approximately 0,3 m/s ("creep speed") sampling rates of 120 Hz, 130 Hz and 150 Hz were used and, at approximately 4,0 m/s, a rate of 1000 or 1500 Hz is used. Typically 256 samples are taken for each channel during the testing described in this report.

The strain gauge conditioner rack interfaces with the load cell and the data acquisition computers (Figure 1). As discussed earlier the VRSPTA system is designed to measure directly the *three-dimensional load* acting on each pin (ie the sensor) during the movement of the tyre over the instrumented pins. The contact stresses are then calculated from the load measurements using a *diamond shaped effective area* covered or represented by each of the pins. The diamond shaped area is a direct result of the diagonal pattern of all the pins fixed to the base plate. The detail of the layout of the *effective area* is given in Figure 3. Note, however, that this diamond shaped area is transformed to an equivalent rectangular area (of width equal to 17 mm) in order to obtain the "effective length" over which the loads are measured *per pin*. The resultant effective length in the direction of tyre movement is therefore equal to 250,28/17 = 14, 7224 mm and is used to obtain the total load during the integration process (See later in Section 7, and Footnote 5).

3. CALIBRATION OF THE VRSPTA SYSTEM

Each of the instrumented pins (sensors) is calibrated independently using a high precision (± 1 per cent according to the manufacturers calibration report) miniature load cell. A separate calibration frame is installed on top of the surface of the VRSPTA system and calibration of each of the three directions of each instrumented pin is done from zero load to a safe maximum recommended load of approximately 500 Newton[2]. This is repeated several times to provide for a linear fit between the voltage output and the load reading from the high precision load cell during the calibration. This linear fit is obtained for each of the total of 60 channels of the VRSPTA and then used in the software to convert the voltage output from the strain gauges to load.

The effective diamond shaped area (Figure 3) is applied during post-processing to convert the various load components to the respective *average contact stress* components over that area. The laboratory accuracy found during the final calibration of the VRSPTA system is discussed in the next section.

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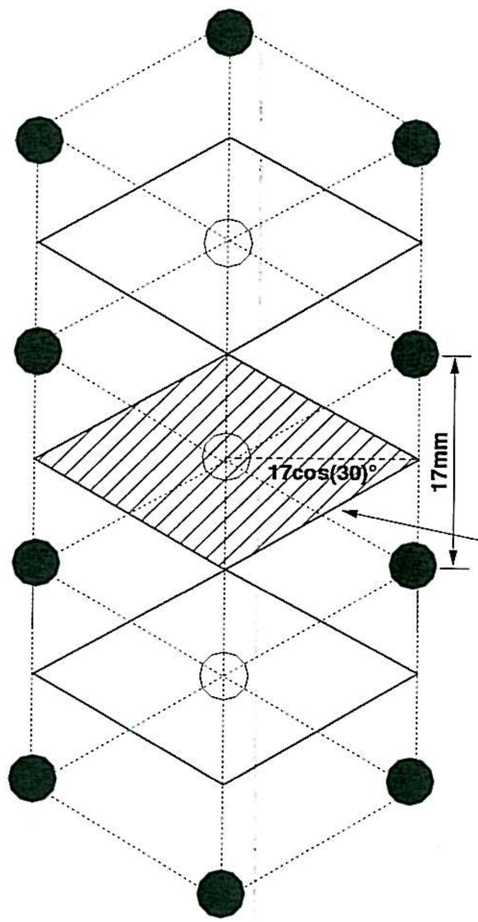
2 The failure capacity of the individual pins was also studied and it was found that the vertical failure capacity of the pins used in the current VRSPTA system is approximately 5 to 10 times greater than the horizontal failure capacity. The horizontal failure capacity is approximately 2 kN (equivalent to a braking, accelerating or transverse stress of approximately 8 000 kPa). This was considered adequate for the purposes of the range of stresses envisaged for evaluation with this system.



Area of ONE Triangle = [17 cos(30) * 17 * 0.5] mm^2

Area of Triangle = (125.1407) mm^2

Area of Hexagon = 125.1407 * 6 mm^2

Area of Hexagon = 750.844 mm^2

Effectively there are 3 pins,

therefore effective area of ONE Pin = 750.844 / 3

Effective Area of each Pin = 250.28 mm^2

Effective Area = ½(17*17)cos30)*2 = 250,28 mm^2

FIGURE 3

CALCULATION OF THE DIAMOND SHAPED EFFECTIVE AREA CARRIED BY EACH OF THE INSTRUMENTED AND NON-INSTRUMENTED PINS OF THE VRSPTA

C:\TUDELFT\FIGURE3.DRW

4. ACCURACY OF THE VRSPTA SYSTEM

4.1 General

It is stressed that the total accuracy (ie systematic and random errors) associated with the current VRSPTA system, regarding the accurate registration of the contact stresses between the tyre and the pavement surface, is mainly determined by the following factors:

(i) the accuracy of the conversion of a physical parameter (viz. force) calculated from the voltage output of the measuring pins, and then the conversion to stresses by dividing the calculated forces by a constant *effective* area. The initial conversion from voltage to load contains a certain systematic error with respect to the linear fit obtained in the laboratory as well as, to the spread of the data around the regression function;

(ii) the accuracy of the *simulation* of what actually happens at the interface between the tyre and real pavement, as the surface of the VRSPTA differs from that of an actual pavement. In this case the *effective friction* is regarded as the dominant factor. This is the second source of a systematic error from the VRSPTA.

(iii) Random errors relative to total applied static load due to the non-laboratory conditions under which the current system operates in the field with the HVS. Typical results are given in Appendix K and this aspect is discussed in more detail in Section 4.4.

The second factor is considered far more uncertain than the first factor and depends on two important parameters: the *effective stiffness (ie "rigidity")* of the VRSPTA, and the *effective friction* between VRSPTA and tyre. This needs to be evaluated relative to the effects found on real pavements.

The *effective friction* characteristics of the VRSPTA system are discussed in Section 4.3.

The effective stiffness in the vertical direction may influence the distribution of the vertical stresses, but not the sum total of those forces/stresses. As long as the VRSPTA vertical stiffness is in the same order of magnitude as that of a pavement, which is an order of magnitude higher than that of a tyre, it may be considered adequate for the purpose of this study.

The effective stiffness in the horizontal/longitudinal direction is very important for the shear forces that may develop. In the extreme case of zero stiffness (or, for that matter, zero friction) virtually no shear forces can exist (e.g. in an aquaplaning situation). Therefore post measurement calculations were made of the horizontal displacements of the top of the VRSPTA pins underneath an area of shear stress. These were compared with the displacements of an asphalt pavement under the same load, calculated with BISAR [de Jong, et al, 1973]. A range of asphalt stiffnesses was used here, representing various temperatures experienced in The Netherlands. The VRSPTA displacements were well within the BISAR calculated range, implying that the effective stiffness of the VRSPTA pins (mobilized by the effective transfer of load through effective friction between the tyre and the surface of the VRSPTA) in the horizontal direction is similar to that of an asphalt pavement [Groenendijk, 1996].

4.2 Laboratory calibration

Each of the load cells (i.e instrumented pins) of the VRSPTA system was calibrated with a high precision miniature load cell[3], in all three individual directions, up to a load of 500 N, as was briefly mentioned in Section 3. The miniature load cell has an accuracy of 1 per cent of full scale, i.e. 1 per cent x 500 Newton = 5 Newton.

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3 The miniature load cell was also calibrated in the laboratory at the Division of Roads and Transport Technology, CSIR using dead weights and a value of g= 9,7862 m/s^2, measured on CSIR campus. This resulted in an accuracy of 0,5 per cent for the miniature load cell.

The laboratory calibration was initially done with "steel to steel" contact between the miniature load cell unit and the VRSPTA pin, which resulted in some "cross talk" from some of the bottom strain gauges, owing to bending moments created as a result of some uneven contact between (micro) steel surfaces. In order to eliminate this "cross talk" during laboratory calibration, a 1 mm rubber interface between the surface of the pin and the high precision load cell was inserted and the calibration redone with "rubber to steel", through which the load is applied to the pin (similar to a rubber tyre). With this approach most of the "cross talk" was eliminated from the instrumented pins and it is also more representative of the "true" measuring condition in the field (i.e. "rubber to steel").

During *laboratory calibration* it was found that the instrumented pins of the VRSPTA resulted in an overall (all three directions, x, y, z) goodness of a linear regression between the load (Newton) input and voltage output of $r^2 = 0,99$. Typical data are given in Appendix L, Figure L1 and in the associated table in the appendix. In order to define the variation of the load data around the mean value (i.e the linear regression), the *confidence interval estimate method* proposed by Kirkpatrick [1974] was used.

Therefore, in addition to the basic regression function, confidence limits for the regression function at 80, 90 and 95 per cent probability were calculated from Equation 1 [Kirkpatrick, 1974].

$$CL_P = [A' - B'x] +/- [t_{\alpha,v} * s_{y|x} * \sqrt{1 + \frac{1}{n} + \frac{(x - \bar{x})^2}{\sum (x_i - \bar{x})^2}}] \quad .....\text{Eq. 1}$$

Where: CL_P = Confidence limits at probability P
A' and B' = Regression coefficients
x = value of independent variable at which the confidence limit is calculated
$t_{\alpha,v}$ = t-value from Student's t distribution for $\alpha = 1 - P$ (P = probability of 80 per cent, 90 per cent and 95 per cent) and v = degrees of freedom (n - 2)
$s_{y|x}$ = standard error of estimate calculated from Equation 2 [Kirkpatrick, 1974]
x_i = i-th known value of the independent variable from the observed data points (x_i, y_i) for i = 1 to n
$\bar{x}$ = mean of the observed values of the independent variable

With

$$s_{y|x}^2 = \frac{1}{n-2} \sum (y_i - (A' + B'x_i))^2 \quad .....\text{Eq. 3}$$

Where: $s_{y|x}^2$ = error variance about the regression
y_i = i-th known value of the dependent variable from the observed data points (x_i, y_i) for i = 1 to n

The first two terms of Equation 1 (in first square brackets) represent a straight line and the prediction limits are calculated by adding/subtracting the quantity calculated in the third term (in second square brackets) of the equation. To determine the prediction limits for a specific value of the dependent variable (i.e the VRSPTA measured total load) , taking both the variation in the regression coefficients and the variation of the dependent variable around the regression function into consideration, Equation 1 [Kirkpatrick, 1974] should be used.

With this method therefore, the load prediction interval around the mean value (i.e regression value) for a certain confidence limit is defined. A typical result from the VRSPTA measured loads is given in Table 1 below. The data clearly indicate that the conversion from volts to load for the instrumented pins can be done successfully using the linear regression obtained from zero load to a full scale of 500 Newton, with a maximum prediction limits of +/- 3 per cent of full scale load at a 99 per cent confidence level.

TABLE 1: TYPICAL CONFIDENCE INTERVAL ESTIMATES (FROM EQ. 1) OF LOAD VS VOLT FOUND DURING LABORATORY CALIBRATION OF THE VRSPTA INSTRUMENTED PINS

CONFIDENCE INTERVAL (%)	PREDICTION LIMITS AS A +/- PERCENTAGE OF FULL SCALE (@ 500 Newton)*
80	1,526
90	1,963
95	2,346
99	3,105

* These limits indicate the percentage deviation from the regression line, for example : at 80 per cent confidence level the deviation is +/- 1,526 per cent of 500 Newton, i.e + 7,63 Newton, or - 7,63 Newton from the regression line.

4.3 Surface friction conditions of the VRSPTA system

The surface friction characteristics of the VRSPTA were tested earlier [de Beer, 1995a] with the TRL (Transport Research Laboratory, UK) Pendulum Skid Resistance Tester, after Road Note 27 [1960]. In dry conditions this gave a skid resistance value of 76 (mean of n = 15 values, standard deviation, s = 1,1). In wet conditions the skid resistance was 37 (n = 10, s = 4,7). The value of 37 relates to a "potentially slippery" road (typically values < 45), according to RN 27 [1960]. The measured value of 76 under dry conditions on the surface of the VRSPTA relates to an equivalent road surface with a "good" skid resistance, fulfilling the requirements of even fast traffic and making it most unlikely that the road would be the scene of repeated skidding accidents according to RN 27 [1960].

It should be mentioned that RN 27 [1960] requires the skid resistance testing to be done in "wet", i.e. the most unfavourable, condition. As the measurements with the VRSPTA are done in a dry condition, however, it can be argued that the friction between the rubber tyre and the VRSPTA steel surface is relatively high. This represents a condition where the horizontal forces between tyre and VRSPTA can be considered as being relatively close to the expected maximum forces (hence to maximum stresses). It is therefore unlikely that these stresses in practice will be *underestimated* by the current VRSPTA system. However, it is acknowledged that the *effective friction* between the test tyre and the VRSPTA surface has a dominant effect on the magnitude of the various stresses obtained in this way but, as stated, the current VRSPTA surface represents an "average equivalent dry road surface" according to the Pendulum test.

Further research work should also concentrate on varying the *effective surface friction* conditions of the VRSPTA. However, this was outside the scope of this project.

4.4 Field measured accuracy and variation in VRSPTA load relative to the HVS static load found during this study (ie random errors)

The *accuracy* and *variation* in VRSPTA measured load relative to the HVS static load were also determined by the tests done with this study. Some results are graphically illustrated in Appendix K. The variation in stress obtained here is considered as part of the *random measurement errors* associated with the current VRSPTA system of measurement.

The *"field accuracy"* (ie random error) was determined as follows: A linear regression (forced through zero, therefore no intercept) was performed between the HVS static reference load as the independent variable, and the VRSPTA measured load as the dependent variable. The *field accuracy* was then determined by calculating the *difference* between the average (regression) value and the HVS static reference load. This is numerically the same as expressing {1,0 - (value of the x- coefficient, found from the regression analysis)}, as a percentage. This percentage value is an indication of the relative size of the random error that can be expected if the tyre traverses the same path over the VRSPTA. This accuracy concept is illustrated in Figure 4. In addition to the field accuracy, *confidence interval estimates* are also given to define the scatter of the VRSPTA results around the regression line (similar to those obtained for given in Table 1). Confidence interval estimates for 80, 90, 95 and 99 per cent are given for the load/inflation pressure conditions given in Table 2.

Detailed data analyses for each test condition are given in the tables . The associated figures are given in Appendix K. In addition to the accuracy and confidence interval estimates, the *coefficient of variance (COV)* was also calculated. The COV was obtained by taking the square root of the calculated (estimated) variance {as given by Kirkpatrick [1974], p 330} to obtain the standard deviation, S. The COV was then calculated by dividing the standard deviation (S) by the average (regression value) for that particular load level and expressing the result as a percentage. These analyses are illustrated in Figures K3, K6, K9 and K12 in Appendix K.

The results of both the field accuracy and confidence interval estimates are given in Table 2 below.

TABLE 2: FIELD ACCURACY : REGRESSION VALUE COMPARED TO HVS STATIC LOAD, AND THE CONFIDENCE INTERVAL PREDICTION LIMITS IN +/- kN OF TOTAL APPLIED LOAD.

TEST CONDITIONS: (25 kN to 100 kN @ 500 kPa to 1100 kPa, see also Table 4))	FIELD ACCURACY: REGRESSION COMPARED TO HVS STATIC LOAD (Fig. 4) (%)	CONFIDENCE INTERVAL ESTIMATE (+/- kN) OF TOTAL APPLIED LOAD (Eq 1)			
		80 (%)	90 (%)	95 (%)	99 (%)
LINTRACK OLD (USED) TYRE @ HVS CREEP SPEED (0,281-0,322 m/s)	+0,3	3,28	4,20	5,07	6,66
LINTRACK OLD (USED) TYRE @ HVS TRAFFIC SPEED (2,518-4,524 m/s)	+1,2	4,85	6,20	7.50	10,0
LINTRACK NEW TYRE @ HVS CREEP SPEED (0,263-0,327 m/s)	+2,6	3,60	4,60	5,55	7,30
LINTRACK NEW TYRE @ HVS TRAFFIC SPEED (2,405-3,417 m/s)	+3,7	3,20	4,10	4,90	6,56

The table indicates that the field accuracy of the VRSPTA varies between + 0,3 and + 3,7 per cent. As far as the total load is concerned, a slightly better accuracy was obtained for the old Lintrack tyre than for the new tyre. It should, however, be noted here that there are several ways of obtaining total load by integration, based on an accurate estimation of the speed of the tyre across the VRSPTA system. This is discussed in more detail in Section 7.

If the spread of the data around the mean (regression value) is investigated, the table indicates a slightly wider range (+/- 3,28 kN to +/- 10,0 kN) for the old Lintrack tyre, than for the new tyre (range: +/- 3,20 kN to +/- 7,30 kN). It is believed that this could be attributable to the relatively **uneven wear** that was found on this tyre (See Section 5, Table 3), causing a "bridging" effect over the instrumented pins on the VRSPTA surface. This means that some of the measuring pins are "bridged" by the uneven tyre/VRSPTA surface interface, causing them to measure less and some pins to measure relatively more loads than the "bridged" ones.

It should be emphasized that this **does not** give a false impression of the contact stress at that particular tyre circumferential position, but rather a more true stress pattern, since the tyre is indeed only **partly in contact** with the road surface (or the VRSPTA surface in this case), at that particular circumferential tyre position. Only the *total load* recovered in this condition will be *lower* than the total load applied to the full tyre patch. This, however, may be considered to be a disadvantage of the current " time based centre row " of instrumented pins of the VRSPTA system but only if a damaged tyre is used at **one of the damaged positions** on the tyre circumference in contact with the instrumented pins.

The best way to eliminate this is to inspect the tyres before VRSPTA testing, and run several tests at several circumferential positions around the tyre. In this way more complete (and non-uniform, if tyre is damaged) contact stress distributions and better *total* load measurement are possible. A similar effect may also occur near the edge of a tread groove. Since the tread grooves are mostly in a zigzag pattern, the measuring pin may just be in the groove, registering no load at all, whereas leading and trailing pins receive the full load. Slight transverse shifts may then be a cause of the differences obtained between repeat measurements (ie part of random error) at the same tyre circumferential position. See also Section 6 (b) in this regard.
The reasons for inaccuracies of the VRSPTA system defined above could be a result of many factors, such as:

- Irregular tyre surface owing to local isolated wear on individual ribs of the tyre crossing the instrumented pins

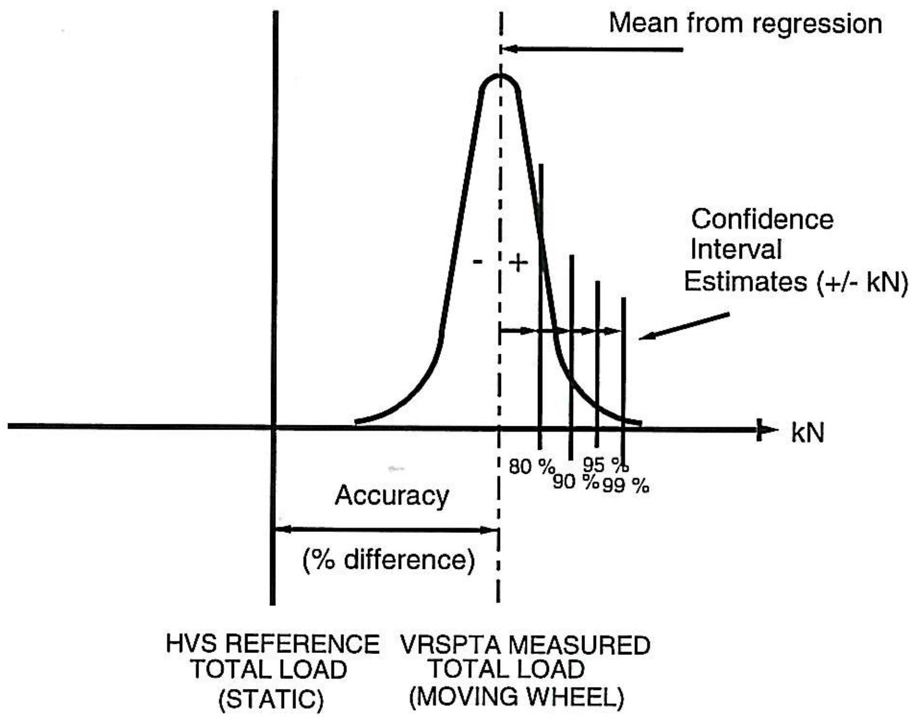

FIGURE 4
DEFINITION OF THE "ACCURACY" CONCEPTS USED IN THIS STUDY WITH THE VRSPTA SYSTEM VS HVS STATIC LOAD

of the VRSPTA;
- HVS - specific induced dynamic loading;
- Non-uniform tyre/VRSPTA contact at interface as a result of local tyre patch deformation;
- Systematic errors in speed measurements across the VRSPTA;
- Random errors from the total method of measurement, etc.,

The above should receive further attention in future measurements of this kind.

It should, however, be remembered that the VRSPTA is relatively accurately calibrated in the laboratory (ie minimizing the systematic errors), and that it actually "measures what it feels" in the field (ie the influence of random errors), which is far from laboratory conditions. Although some errors are associated with this system it is the authors' belief that the

VRSPTA results should be compared with the traditional load model where, typically, a circular uniform vertical pressure equal to the tyre pressure with no horizontal stresses is used to define pavement loading.

The results given here show, amongst other findings, that the contact area of wide base tyres is of a more rectangular shape and that the vertical contact stresses can be more than twice as great as the tyre inflation pressure. The distribution of the vertical stresses in the centre zone across the tyre width are clearly different from those in the edge zone. It was also found that relatively large shear stresses might occur and in some cases it were of the same order of magnitude than the tyre inflation pressure.

Furthermore, the distribution of stresses of normal tyres (with tread grooves) is highly irregular, and more like a "saw tooth" effect (See Appendices A to H). For the trimmed down (or buffed) tyre the stress distributions are more uniform, similar to those which might be expected for a worn-out tyre (See Appendices I and J) .Considering these huge differences between traditional pavement model and new data, the authors consider the indicated accuracies and COVs to be acceptable for the purposes of this study.

It should also be noted that surface irregularities in a pavement, such as the protrusion of stone chippings may lead to extreme concentrations of contact stresses [Woodside et al, 1992]. These conditions were not studied here. However, it is strongly recommended that these be included in further studies of this nature.

5. DESCRIPTION OF THE TYRES AND LOAD/INFLATION PRESSURE TEST CONDITIONS IN THIS STUDY (Test Matrix)

5.1 Description of tyres and tyre wear

Two wide base single radial type tyres were tested in this project: a (LINTRACK used or old tyre) Bridgestone 425/65 R 22.5 R160AZ and a (new) Bridgestone 425/65 R 22.5 R164BZ.

The old tyre (R160AZ) was bought in 1990 and was used at the LINTRACK Accelerated Pavement Testing Facility of TUDELFT between 1990 and 1996 to apply 4 million repetitions of a 75 kN wheel load to test pavement No. I [Groenendijk et al, 1994, 1996a, 1996b], and 650 000 repetitions of a 75 kN wheel load to test pavement No. Va (travelling about 60 000 km in the process). It was also used for response measurements on LINTRACK test pavements Nos. I, IV and Va [Bouman et al. 1991; Mante et al. 1995]. Its tread surface was worn considerably during those tests, with a tread depth reduction from 15,5 mm to an average of 11,3 mm (see Table 3 below).

The fifth tread rib showed local depressions of 5 mm to a maximum of 7 mm below the rest of the tyre surface, over lengths of 5 to 20 cm. At one location the fourth tread rib also showed such a depression. The cause of these depressions ("local wear patches") is unknown, but may be due to local abrasion and/or some hydraulic oil on the LINTRACK test area. Apart from these depressions, the tread wear was fairly uniform around the tyre, but relatively greater at its edges than in its centre plane.

The depth of each of the five tread grooves was measured manually at five positions along the tyre circumference, as depicted in Figure 5. The groove depth was measured relative to a fixed reference . The reference used was a flexible steel ruler, held flat (i.e. bent) in contact across the tyre surface. At positions 1 and 3 the tyre had worn away rather evenly, at positions 2 and 4 the fifth rib was worn below the rest of the tyre surface, at position 5 this was true for ribs four and five (counting from starboard).

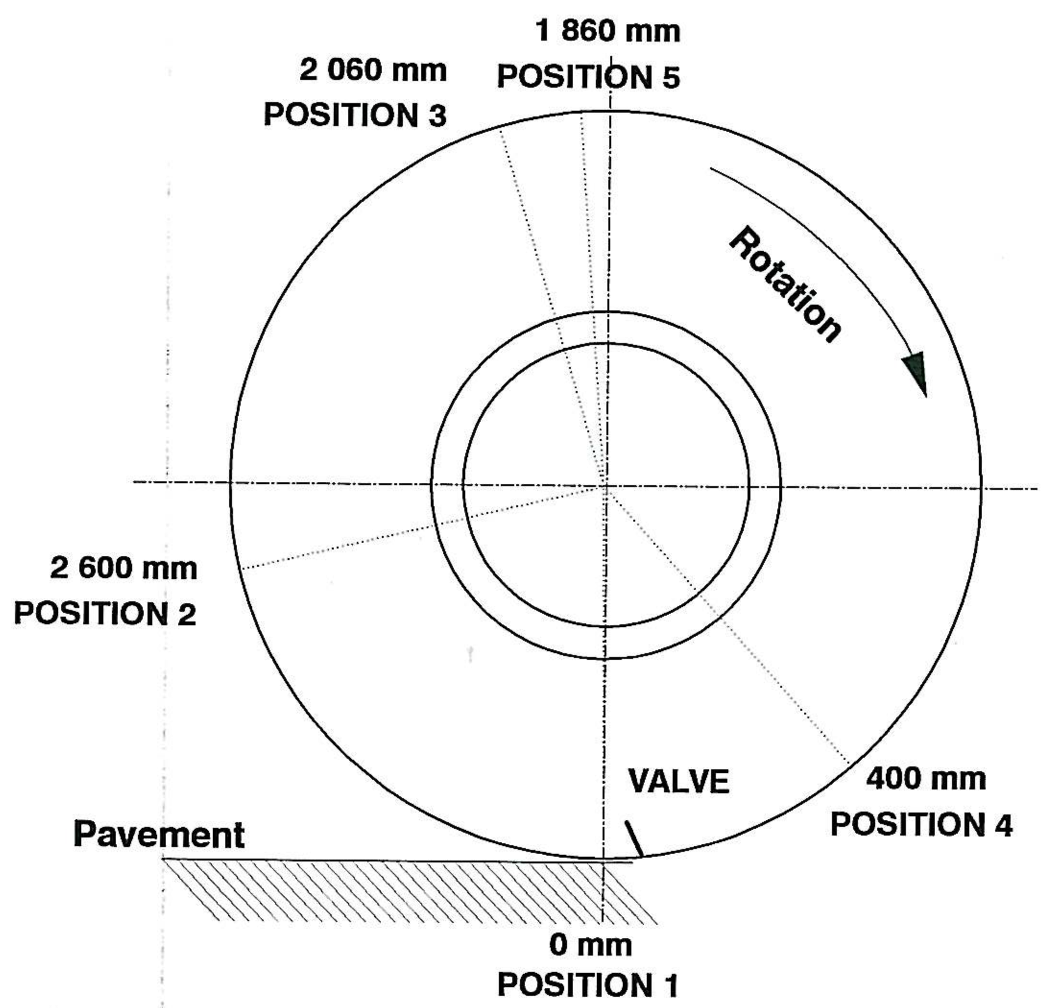

FIGURE 5

CIRCUMFERENTIAL MEASUREMENT POSITIONS AROUND THE USED (OLD) LINTRACK TYRE DURING SPECIAL TESTING

C:\TUDELFT\FIGURE4.DRW

TABLE 3: GROOVE DEPTH IN MM, USED (OLD) BRIDGESTONE R160AZ AT VARIOUS CIRCUMFERENCE POSITIONS

(TYRE LOAD = 5 KN @ 950 kPa DURING MEASUREMENT)

Groove Number	Position 1	Position 2	Position 3	Position 4	Position 5	Ave.
1	10,2	10,4	9,6	9,9	10,1	10,0
2	11,7	12,1	11,8	11,8	11,9	11,9
3	13,0	12,4	12,9	12,8	12,4 (4,7)	12,7
4	11,8	11,0 (5,1)	12,1	11,7 (4,4)	11,3 (6,3)	11,6
5	10,4	9,0	10,8	10,5	10,4	10,2

NOTE: (5,1) = Indicates isolated or local wear of 5,1 mm *below* reference level from steel ruler at that position, etc.

Two new tyres (R164BZ) were bought in 1996 as replacements for the existing used (old) R160AZ (which specific type was no longer available in The Netherlands at that time). It will be used in further Accelerated Pavement Testing (APT) in the LINTRACK Facility of TUDELFT. It has a groove depth of 16.7 mm (number of samples, n = 10, standard deviation, s = 0.3 mm). The R164BZ is built using Bridgestone's TCOT (Tension Control Optimization Theory) concept, which allegedly results in less deformation in the belt and heel zone of the tyre. According to the manufacturer this results in longer tyre life and offers improved possibilities for retreading.

5.2 Tyre load rating, loading on Lintrack and VRSPTA test matrix

Both the tyres discussed in the previous section may be considered typical of the wide base single tyres which are currently used in the Netherlands. Over the past decade there has been a continuing trend in The Netherlands to replace dual wheels on trucks with these wide base single tyres. This has resulted in about 30 - 40 per cent of all truck axles being fitted with wide base singles at the moment[4].

As the wide base single tyres typically have smaller areas of contact with the pavement and higher inflation pressures than dual tyres, they are often considered to be more detrimental to the pavement surface. Such considerations do not consider an unbalanced dual wheel, however, where one of the tyres is carrying more than half of the total wheel load. This, of course, may result in conditions much more detrimental than a wide base single.

Both the VRSPTA tested tyres are rated for load range L, 20 PR (ply rating), giving a maximum load of 50.5 kN (11 350 lbs) at 830 kPa (120 psi). However, to accelerate the pavement testing, the R160AZ tyre was *overloaded* to 75 kN in the LINTRACK, just as overloading occurs frequently in practice, causing increased damage to the pavement [Saathof et al. 1992]. As truckers overload their tyres in practice, they generally also *overinflate* them, to prevent the bulging appearance of the sidewalls that would betray them to the law enforcement officials. Therefore, a tyre pressure of 950 kPa was chosen in the LINTRACK tests at a load of 75 kN. This created the same visual appearance of the tyre as the nominal loading of 50 kN at 850 kPa.

Response measurements were made in LINTRACK to determine the reaction of the pavement at a wide range of wheel loads and tyre pressures [Bouman et al, 1991; Mante et al, 1995]. These load conditions are given in Table 4 and are

4 In South Africa, however, the percentage of wide base singles is still relatively low , being approximately 5 per cent, but is growing as a result of the legal axle load being increased from 80 kN to 88 kN during 1996.

also the test matrix used in the measurements described in this report. These load/inflation pressure conditions were chosen, starting from the 50 kN, 700 kPa dual wheel, which is the standard used for the pavement design guide of the Dutch Ministry of Transport, Public Works and Water Management [RHED, 1994]. This standard was compared with a wide base single tyre of the same wheel load and tyre pressure. The wheel loads were then increased with 25 kN increments, and the tyre pressures in 200 kPa increments, with the additional 75 kN / 950 kPa combination described above.

TABLE 4:TEST MATRIX FOR VRSPTA TESTS ON THE TWO TYRES USING TWO SPEEDS ON THE HVS

Tyre pressure (kPa)	500	700	900	950	1100
TYRE LOAD (kN)					
25	X	X	XX	XX	XX
50	X	X	X	XX	XX
75	X	X	X	X	X
100		X	X	XX	X

Legend:

X: Reflects 3 repeat measurements at each of the two speeds under the HVS. The test wheel speeds over the VRSPTA system were Creep speed, ranging between 0,26 and 0,33 and at HVS Traffic speed, ranging between 3,4 and 4,5 m/s.

XX: Reflects extra measurements in the matrix done outside the brief of the contract, but included to cover as wide a range as possible range of test conditions for a more complete set of data.

Approximate tyre load/inflation limits prescribed by the tyre manufacturer (See Figure 6)

Lintrack test condition (in a special mode of *overloading* and *overinflation*, specially selected for Lintrack research purposes to represent an equivalent condition of 50 kN @ 850 kPa.

Earlier research with the VRSPTA [De Beer 1994, 1995a, 1995b] has shown that for bias/cross ply tyres (buffed down) the largest contact stresses (both vertical and transverse) occurred under tyres that were relatively *overloaded / under-inflated*. Under such conditions, the sidewalls of the tyre bear a significant portion of the load, resulting in relatively high stresses under the tyre edges and high transversal inward shear stresses. Jacobs [1992] has shown that these can result in high transverse tensile stresses close to the surface in the pavement, possibly causing longitudinal surface cracking.

The combinations of high load and low tyre pressure were therefore especially selected for investigation. This was limited however by the excessive deformation of the tyre at the most extreme combination of 100 kN at 500 kPa. This posed a problem both as regards maximum possible vertical wheel movement (both in LINTRACK and the HVS) and safety. Furthermore, this was regarded as an unrealistic case as no trucker would drive with such a badly deformed tyre (both for safety and law enforcement reasons).

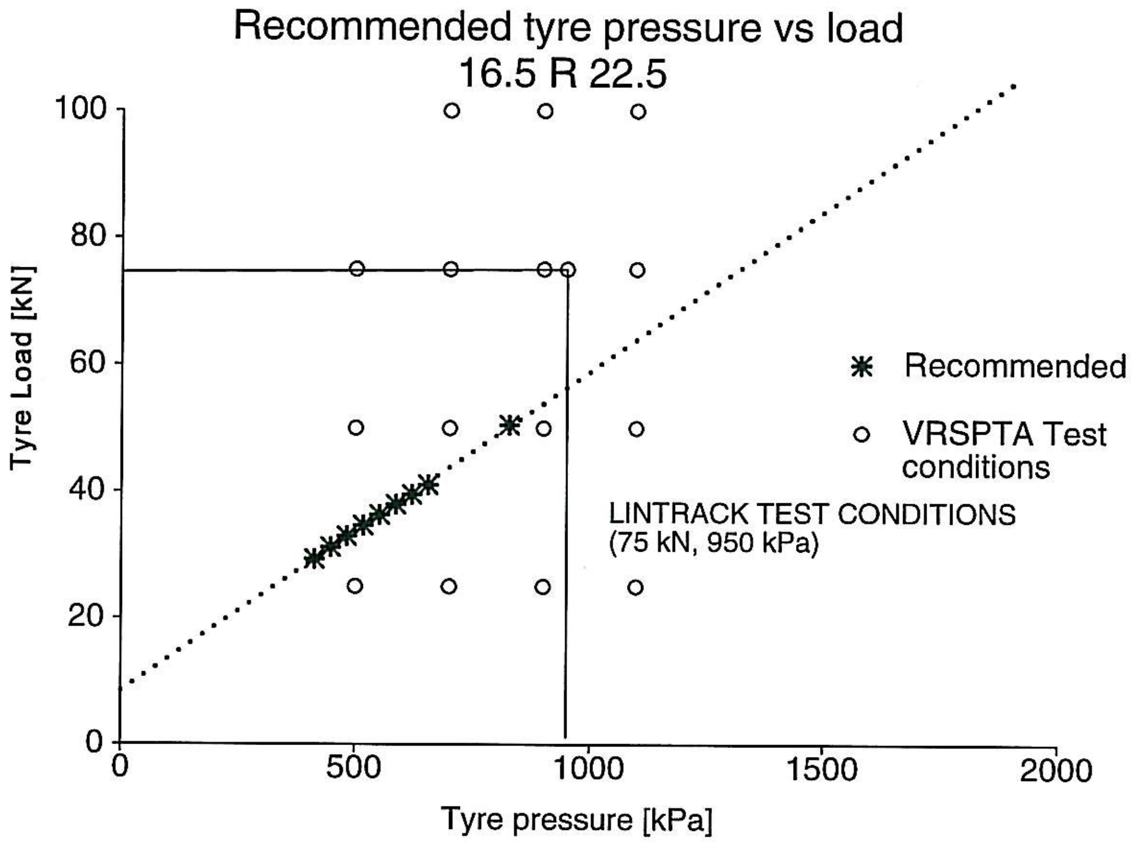

FIGURE 6: TYRE LOAD/INFLATION PRESSURE CONDITIONS STUDIED WITH THE VRSPTA, RELATIVE TO RECOMMENDED CONDITIONS FROM TYRE MANUFACTURER.

The results for the load conditions mentioned in Table 4 are illustrated graphically in Appendix A for the used LINTRACK Bridgestone R160AZ at creep speed, and in Appendix B at traffic speed. Appendices E and F report these conditions for the new Bridgestone R164BZ at these two speeds.

6. SPECIAL TESTS

Additional investigations (ie "Special tests") were made into the influence of slight variations in other parameters at a constant speed , load and tyre inflation pressure condition. This was done to investigate the sensitivity of the measurements to external influences. The chosen test condition was 75 kN / 950 kPa, being the LINTRACK performance test condition, as variations at this condition may have happened in the LINTRACK and influenced the pavement performance. For best measurement accuracy, these variations were only tested at HVS creep speed.

The results of the special tests are reported in Appendix C for the *used* Bridgestone R160AZ and in Appendix G for the *new* Bridgestone R164BZ.

a. Specific test points on the perimeter of the used (old) and new Lintrack tyre:

   Care was taken to test the full matrix of test conditions at the same point (within 5 cm of Position 1 in Table 3) of the tyre perimeter. However, as the R160AZ had worn unevenly around its perimeter, especially Rib 5, this influenced the stress distribution of the moving wheel as measured with the VRSPTA system. See Figure C4 (Appendix C) in this regard. Therefore, the four other points listed in Table 3 were also tested.

   For the new R164BZ tyre three additional points were tested, each at 90° angles, to indicate the possible variation around a tyre perimeter.

b. The lateral position of the tyre on the VRSPTA.

   As the measuring pins have approximately the same transverse dimension as the tread grooves (top width of pins c. 9,7 mm, 17 mm c/c vs groove width c. 15 mm, c. 37 mm c/c), it may cause a difference whether a pin is loaded fully, partially or not at all by the tyre tread. To test this, the loaded HVS tyre was shifted laterally three times at approximately 5 mm intervals (the VRSPTA pins being 17 mm apart centre to centre).

c. The vertical tilt (camber) of the tyre centre plane relative to the pavement.

   In practice, roads are usually cambered and it is well known that often the outside wheel carries more load than the inside wheel [Croney, 1991]. Furthermore, the road and/or wheel camber may induce an additional transverse (or lateral) component of the wheel load at the tyre/pavement interface. To simulate this, the HVS (which was originally parallel to the pavement and VRSPTA surface) was tilted in two successive steps, resulting in an effective tilt of between 2 per cent and 4 per cent, respectively. See Appendix C (Figures C8 and C9) and Appendix G (Figures G7 and G8). It is believed that this should give some information about the influence of pavement camber and/or truck wheel tilt on the various stress distributions. It should also give information about the influence on these measurements if the HVS was not fully parallel to the pavement, quantifying the influence this might have on Accelerated Pavement Testing (APT) in general.

d. Induced shear across the VRSPTA system

   An increased side shear force was introduced on the tyre. This was done to simulate a steering or side force on the tyre by shearing (skewing) it across the VRSPTA. This has also direct importance for APT. The lateral wander in normal LINTRACK operation is accomplished by "skewing" the tyre across the pavement (ie moving the entire installation sideways during the rolling motion of the wheel). With the HVS, however, the tyre experiences some torque at its turning point ("dead area") as the entire load beam is pivoted around this point towards the other end. This may also cause additional transverse (or lateral) shear forces at the tyre/pavement interface.

7. CONTACT STRESS MEASUREMENT PROCEDURES

7.1 Load

The HVS wheel load is set statically by means of a manual hydraulic valve at the side of the load carriage. It is controlled by means of a 100 mm diameter dial type hydraulic pressure gauge indicating decaNewtons, with a maximum reading of 25 daN, divisions of each 0,5 daN, about 4 mm apart.

Another load reading (static and dynamic) is recorded from a digital (4 digits of which 1 decimal) readout box at the measurement console. The readout box receives the load data by Radio Telemetry (RT) transmission directly from the on-line electronic hydraulic pressure transducer at the HVS load carriage.

In addition, the static load can be measured independently by means of a portable scale set in a cavity in the pavement surface. Digital readout (4 digits of which two decimal) is on a Nagata SB-99 device (Maximum load 60 kN).

Before a measurement series with the VRSPTA is started, the load results from these devices are compared. Load readings taken with the used LINTRACK R160AZ tyre at 950 kPa are shown in Table 5. Some detail results are graphically illustrated in Appendix K.

TABLE 5:COMPARISON OF LOAD MEASUREMENTS WITH DIFFERENT DEVICES DURING THIS STUDY
(USED LINTRACK R160AZ TYRE AT 950 kPa)

Inflation Pressure (kPa)	HVS hydraulic pressure gauge (kN)	HVS on-line pressure transducer ("Box") (kN)	Independent static scale (kN)
750	25	23.6	24.65
950	50	48.2	52.35

This indicates a difference of approximately 5 per cent between these devices, which is considered satisfactory regarding the non-laboratory conditions (ie field conditions under which the HVS normally operates) for this specific study.

7.2 Wheel speed

The wheel speed is measured independently by two systems. The first consists of two optical (Infra Red, IR) beams, placed 100 and 200 cm upstream of the measuring pins on the VRSPTA, and controlled by the Data Acquisition System (DAS). The second system was added especially for these measurements and consists of two micro switches placed in positions of removed pins 7-9 in the first and last row of the VRSPTA (i.e. 745 mm apart). These two micro switches are monitored by a dedicated program on a separate computer.

As the latter system has a more accurate measuring distance, which also exactly covers the VRSPTA, the data of this system were considered more reliable and were intended to be used in later evaluation of the measured load data. Subsequent analysis of the data of this project indicated that the calculation of total load was very sensitive to speed measurements and that the speed should be measured to three decimal places, in m/s.

Accurate recording of speed is one of the most important aspects relating to the accuracy in load measuring with the VRSPTA, accepting all other factors to be reasonable (ie laboratory calibration, etc). This is because the VRSPTA is a *time based* measuring system from which length intervals ("sample length") are obtained by dividing the measured wheel speed (m/s) by the sampling rate (samples/sec). These length intervals are then multiplied by the measured load values, and divided by an "effective length" of sampling *over each pin* in the direction of tyre movement to obtain the total measured load. (See more detailed discussion later in Section 7.3.2). Therefore any errors in the speed measurement will directly influence the total load measurement by exactly the same magnitude (i.e. 10 per cent *overestimation* of speed results in a 10 per cent *overestimation* of the total load).

7.3 The data acquisition system (DAS) and total load

7.3.1 DAS

The data acquisition system (DAS) produces three ASCII files, one for the results of each load direction (Y = transverse, X = longitudinal (direction of traffic), Z = vertical). In each file, the data are arranged in table format with 21 columns, one column for each measuring channel (i.e. measuring pin). For each channel, 256 data values are sampled. Sample frequency is set at 120 Hz, 130 Hz or 150 Hz at HVS creep speed, and at 1000 or 1500 Hz at HVS traffic speed[5]. These data are given in Newtons, as the DAS software already multiplies the strain gauge conditioner output with the proper calibration factor. On site, these data are transferred from the DAS system to another computer for preliminary data evaluation. This is performed with a macro in Lotus 1-2-3, Release 3.1 (DOS), named:" **NET-PRN.WK3**". (Another macro for the same purpose was subsequently developed to run with Lotus 2.01 (DOS), named:" **NET-PRN.WK1**").

This macro averages the first five samples of each column to find the offset of the channel, if any, that might be caused by zero level drift in the strain gauges or their conditioners. These offset values are checked every day before the start of the measurements. If any offset value gets too high that specific pin is then re-calibrated.

The offset is then subtracted from the data for each channel and the results stored in another ASCII file per load direction, with format, identical to those of the original data files. These will later serve as the basis for further evaluation of the recorded data.

Subsequently, the recorded signals are plotted against sample number, to enable an on-site visual inspection of the validity of the data. This means visual checking for excessive noise on the signal, whether any signal was recorded at all for any channel, whether the full signal was recorded, and whether the signal was only partly recorded because of excessive zero drift or overloading. If anything irregular is detected in the data at this stage the data set is discarded, suitable adjustments made to the measuring system and the measurement is repeated.

In an additional computation, the macro (in file :" **NET-PRN.WK1**", for Lotus 2.01, or "**NET-PRN.WK3** ", for Lotus 3.1, see Table 6) filters out all data with a magnitude (base level) of less than 3 Newton (approximately 12 kPa), to eliminate noise in conditions of zero force .

The *stress increments per pin* are obtained by dividing the force (load) increments by the effective pin area of 250.28 mm² (See Figure 3). The 3-D plots in the appendices are then generated from these stress values in MATLAB [1996].

7.3.2 Total load estimation from the VRSPTA system

The total load measured by the VRSPTA is obtained by integration of all the filtered measured load data from each active pin. For this purpose it is necessary to obtain the correct "sample length" in the direction of tyre movement across the VRSPTA surface. The "sample length" is obtained by dividing the speed by the sampling rate. As stated earlier, speed measurement is very important as it directly influences the calculation of the "sample length" and, hence, the total load. In this project it was found that the speed should be measured up to three decimal places, in m/s.

The speed measurements that were done during this test series, however, were only to the second decimal place and could therefore not be used on their own for the total load calculation. Therefore, another method was used to estimate the speed by using selected lengths of the tyre imprints that were statically done for each load/inflation

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5 The sampling rate used for each of the data files is indicated in the summary sheets given in the Appendices

pressure condition, counting the active results per pin, and then calculating the time required to travel the corresponding length. The corresponding length divided by the time then results in the speed. This speed is then divided by the sampling frequency to obtain the "sample length", which is then multiplied by the VRSPTA measured load data. Finally, this result is then divided by the effective length to obtain the **total load.**

This process for each load/inflation pressure test done for this report is given in steps below:

STEP 1:	Measure the length of the tyre imprints at the most probable contact position with the VRSPTA.
STEP 2:	Filter the measured raw load data at a maximum level of 3 Newton to remove any noise.
STEP 3:	Count the active load data over the tyre patch length per pin across the tyre with.
STEP 4:	Determine the active time increment by dividing the counts of active load data from STEP 3, by the appropriate sampling frequency in Hz.
STEP 5:	Determine the speed for each active pin by dividing the time increment into the measured length obtained in STEP 1.
STEP 6:	Isolate (remove by hand) any obvious incorrect data if they exist. In the data files all data counts < 10, and measured lengths < 50 mm should be disregarded for the speed calculation.
STEP 7:	Obtain the speed range, average and standard deviation of all the selected pins per each tyre imprint and load data.
STEP 8:	Divide the average speed by the sampling frequency to calculate the "sample length" in the direction of tyre movement. This "sample length" is considered valid for all the active pins for that particular test.
STEP 9:	Multiply the active load data (filtered) by the "sample length" obtained in STEP 8.
STEP 10:	Divide the result from STEP 9 by the "effective length" to obtain the average measured load per pin (per the effective area). The effective length is a constant as a result from the geometrical layout of the pattern of pins of the VRSPTA[6] and is equal to 14,7224 mm.
STEP 11	The addition of all the individual values from STEP 10 over all the pins is the **total load** measured with the VRSPTA.

6 The "effective length" is obtained by transforming the diamond shaped area in Figure 3 to an equivalent rectangular area (i.e 250,28 mm^2), with the width = 17 mm. Therefore the length of this rectangular is defined in the direction of loading and is referred to as the *"effective length"*. It is numerically equal to 250,28/17 = 14,7224 mm. The result obtained in STEP 9 should be divided by the effective length because the load data should be *averaged* over the effective length of that rectangular area. This averaging of the load is necessary since the "sample length" is shorter than the effective length, which results in more than one load measurement per the effective length.

8. FURTHER DATA HANDLING PROCEDURES SPECIFIC TO THIS PROJECT

The VRSPTA basic raw data are given in X, Y, Z format files which can be imported to existing data analysis programs such as Lotus 1-2-3 or Matlab, etc. The data files with corrected offsets are used for further evaluation which, for this study, was limited to graphical representation and extraction of peak values, using Matlab Version 3.5i [Matlab, 1996], and the availability of the data on nine (9) diskettes. The contents of the disks and of the associated data files are given in Table 6.

A preliminary, rather cursory scan through the data was done. Some of the main findings and observations are discussed in the next sections.

TABLE 6: SUMMARY OF DISKETTES WITH DATA ACCUMULATED DURING THIS STUDY

DISK NUMBER	*FILE NAMES*	*COMMENTS AND FILE CONTENTS*
DISK 1	*.DRW	LOTUS FREELANCE GRAPHICS OF FIGURES 1,2,3 & 4 IN REPORT
	NOTRIM1.FMT/WK1	LOTUS 1-2-3 (VERSION 2.2) SPREADSHEET FILE OF BUFFED DOWN TO 1,5 mm TREAD DEPTH - OLD LINTRACK TYRE DATA IN FILE CONTAIN SUMMARY OF MAXIMUM/ MINIMUM, ALL DIRECTIONS (ALSO TABLE IN APPENDIX I).
	NOTRIM2.FMT/WK1	LOTUS 1-2-3 (VERSION 2.2) SPREADSHEET FILE OF FULLY BUFFED DOWN (SMOOTH) -: OLD LINTRACK TYRE. DATA IN FILE CONTAIN SUMMARY OF MAXIMUM/ MINIMUM, ALL DIRECTIONS (ALSO TABLE IN APPENDIX J)
	NET-PRN.WK3	LOTUS 1-2-3 (VERSION 3.1). WORKSHEET AND MACRO TO IMPORT RAW DATA : (X/Y/Z).PRN
	NET-SUM.WK3	FILE CONTAIN SUMMARY OF MAXIMUM/ MINIMUM, ALL DIRECTIONS (NEW AND OLD TYRES)
	NNEWS.ZIP	ZIPPED DATA FILE: NEW TYRE (164 BZ): SPECIAL TESTS (*.PRN)
DISK 2	NNEWT.ZIP	ZIPPED DATA FILE: NEW TYRE (164 BZ): TRAFFIC SPEED (*.PRN)
DISK 3	NNEWCB.ZIP	ZIPPED DATA FILE: NEW TYRE (164 BZ): CREEP SPEED (900 & 1 100 kPa) (*.PRN)
	NOLDS.ZIP	ZIPPED DATA FILE:OLD TYRE (160 AZ): SPECIAL TESTS (*.PRN)
DISK 4	NNEWCC.ZIP	ZIPPED DATA FILE: NEW TYRE (164 BZ): CREEP SPEED (500, 700 & 950 kPa) (*.PRN)
	NET.M	MATLAB 3.5i - VERTICAL (Z) DIRECTION, LONGITUDINAL (X) DIRECTION AND TRANSVERSE (or LATERAL) (Y) DIRECTION
	NETNEW.WK1	SUMMARY TABLES IN APPENDICES
	NETOLD.WK1	SUMMARY TABLES IN APPENDICES
	NET- PRN.WK1[7]	LOTUS 1-2-3 (VERSION 2.01). WORKSHEET AND MACRO TO IMPORT RAW DATA : (X/Y/Z).PRN
DISK 5	NOLDC.ZIP	ZIPPED DATA FILE: OLD TYRE (160 AZ): CREEP SPEED (*.PRN)
DISK 6	NOLDT.ZIP	ZIPPED DATA FILE: OLD TYRE (160 AZ): TRAFFIC SPEED (*.PRN)
DISK 7	NTRIM1.ZIP	ZIPPED DATA FILE: BUFFED DOWN TO 1.5 mm TREAD DEPTH OLD TYRE (160 AZ): CREEP SPEED (*.PRN)
DISK 8	NTRIM2.ZIP	ZIPPED DATA FILE: FULLY BUFFED DOWN (SMOOTH) OLD TYRE (160 AZ): CREEP SPEED (*.PRN)

7 This macro (FILE: NET-PRN.WK1) was developed for use in Lotus 1-2-3, Version 2.01, and is **different** from the macro developed for Lotus 1-2-3, Version 3.1 (FILE: NET-PRN.WK3). The macro starts in cell A5000. The summaries of PEAKS are in cells A300, and downwards. The summaries of the calculations of the data are in cells X1 and AC1 and go across the worksheet towards columns BB. ROWS OR COLUMNS IN THIS FILE MUST NOT BE DELETED!

TABLE 6: (Continue):

DISK NUMBER	FILE NAMES	COMMENTS AND FILE CONTENTS
DISK 9	NEW.WK1/FMT	APPENDIX K FILES
	NEW-T.WK1/FMT	APPENDIX K FILES
	OLD.WK1/FMT	APPENDIX K FILES
	OLD-T.WK1/FMT	APPENDIX K FILES
	TRIM1A.WK1/FMT	APPENDIX K FILES
	TRIM2A.WK1/FMT	APPENDIX K FILES
	TTA.WK1/FMT	ACTIVE PINS USED FOR SPEED CACULATIONS
	NETNEW.WK3	MACRO FOR NEW TYRE (SPEED CALCULATIONS)
	NETOLD.WK3	MACRO FOR OLD TYRE (SPEED CALCULATIONS)
	NNEW-RAT.WK1/FMT	STRESS RATIOS - NEW TYRE
	NOLD-RAT.WK1/FMT	STRESS RATIOS - OLD TYRE

9. RATIO OF PEAK (MAXIMUM) STRESSES FOUND IN THIS STUDY

9.1 Stress ratios

9.1.1 Introduction

As noted in the preface, the *aim* of this report is to serve as a ***raw database*** of various contact stress measurements done under the Lintrack tyres, and no *detailed* attempts were made to analyse and interpret the data given here, other than to give a summary of the *stress ratios*, based on the maximum (peak) stresses in three directions obtained from the various tests done. These ***stress ratios*** were calculated by selecting the maximum stress values from the spreadsheets and, were then summarised. They are given in the following format:

Vertical Stress (σ_{zz}) : Transverse (or Lateral Stress (τ_{zy}): Longitudinal Stress (τ_{zx}),

and are discussed here in more detail.

9.1.2 Average ratios of maximum stresses

The values given in Tables 7 and 8 are the average ratios (of maximum stresses per measurement) over groups of test conditions. This means e.g. that the ratio 10,00 : 1,50 : 1,19 for 'HVS creep speed (LINTRACK old tyre)' comprises all 19 different combinations of load and tyre pressure from the test matrix given in Table 4. 'Move transverse over pins (LINTRACK old tyre)' comprises only three situations, all at the same load / inflation pressure. It should be noted that these ratios could further be differentiated into different classes on the basis of load/inflation pressure combinations.

TABLE 7: AVERAGE RATIOS BETWEEN THE MAXIMUM (PEAK) STRESS FOUND IN THIS STUDY RELATIVE TO THE MEASURED MAXIMUM VERTICAL CONTACT STRESS (TAKEN AS 10).

TEST AND TYRE CONDITION RATIOS:	VERTICAL STRESS σ_{zz}	TRANSVERSE (or LATERAL) STRESS τ_{zy}	LONGITUDINAL STRESS τ_{zx}
HVS CREEP SPEED (LINTRACK OLD TYRE)	10.00	1.50	1.19
HVS TRAFFIC SPEED (LINTRACK OLD TYRE)	10.00	1.51	1.27
TYRE DIFFERENTIAL WEAR (LINTRACK OLD TYRE)	10.00	1.22	1.15
NO TYRE DIFFERENTIAL WEAR (LINTRACK OLD TYRE)	10.00	1.68	1.01
MOVE TRANSVERSE OVER PINS (LINTRACK OLD TYRE)	10.00	1.69	1.04
TILT OR CAMBER (2 %-4%) (LINTRACK OLD TYRE)	10.00	1.53	1.23
OVERALL AVERAGE FOR LINTRACK OLD TYRE (free rolling)	10.00	1.52	1.15
HVS CREEP SPEED (LINTRACK NEW TYRE)	10.00	1.28	0.85
HVS TRAFFIC SPEED (LINTRACK NEW TYRE)	10.00	1.35	0.92
TILT OR CAMBER (2 %-4%) (LINTRACK NEW TYRE)	10.00	1.47	1.10
MOVE TRANSVERSE OVER PINS (LINTRACK NEW TYRE)	10.00	1.51	1.96
OVERALL AVERAGE FOR LINTRACK NEW TYRE (free rolling)	10.00	1.43	0.94
WITH SIDEWAYS SHEAR (LINTRACK NEW TYRE) ("non - free rolling"	10.00	3.61	1.37

TABLE 8: AVERAGE RATIOS BETWEEN THE MAXIMUM (PEAK) STRESS FOUND FOR THE OLD LINTRACK TYRE TRIMMED (BUFFED) DOWN, RELATIVE TO THE MEASURED MAXIMUM VERTICAL CONTACT STRESS (TAKEN AS 10).

TEST AND TYRE CONDITION RATIOS:	VERTICAL STRESS σ_{zz}	TRANSVERSE (or LATERAL) STRESS τ_{zy}	LONGITUDINAL STRESS τ_{zx}
HVS CREEP SPEED (LINTRACK OLD TYRE) (Buffed down to 1, 5 mm tread groove depth)	10.00	1.21	1.16
HVS CREEP SPEED (LINTRACK OLD TYRE) (Buffed down to 0 mm tread groove depth)	10.00	1.03	1.06
OVERALL AVERAGE FOR LINTRACK OLD TYRE (buffed down and free rolling)	10.00	1.12	1.11

Tables 7 and 8 indicate that the observed stress ratio of ***10 : 1.5 :1 .0*** appears to be a general finding with regard to both the tested wide base single tyres in a free-rolling mode. Obviously, when acceleration and/or braking are applied the longitudinal stress value will increase. It is also interesting to note that the ratio corresponds very well to a similar finding of a radial aircraft tyre tested by one of the authors during 1994. It therefore appears that the relative maximum contact stress components of wide base single tyre design for trucks resembles those observed for radial aircraft tyres. The aircraft tyre tested at HVS creep speed was an SP44 Goodyear (46 inch x 16 inch, 30 ply rating, 225 mph), 9 inch wide @ 140 kN load) at an inflation pressure of 1448 kPa, and a HVS load range 20 to 80 kN.

For a free-rolling bias/cross ply tyre (buffed down) (10 x 11, 14 ply rating) the stress ratio found with the VRSPTA was roughly ***10 : 3 : 1*** [See De Beer, 1994].

With sideways shear (ie tyre moved over the VRSPTA at an angle), the maximum transverse shear component for the tyre tested in this study was approximately 2.5 times greater than that observed during the free-rolling mode of the same tyre. This translates roughly to an *additional transverse stress* value of 100 to 200 kPa *per degree.* It is interesting to note that earlier testing on a bias/cross ply tyre the sideways shear caused almost a tripling in the transverse shear component [See De Beer, 1994].

Another rather surprising observation from the test results investigated here so far was that the transverse stress for both the "buffed down" conditions of the old Lintrack tyre indicated relatively *lower* values (approximately 20 per cent) than for the treaded case. One explanation of this may be that effectively lower friction occurred between the buffed down tyre surface and the VRSPTA surface. This points to the very important fact and potential influence of the type and nature of the tyre tread pattern on the developed stresses at the tyre/pavement interface.

9.1.3 Maximum ratios of maximum stresses

As stated above, the values in Tables 7 and 8 are the average RATIOS over groups of test conditions. This means that ratios of maximum stress could be found for specific conditions of load / inflation pressure, that are much higher or lower than the average values of Tables 7 and 8. This is shown in Tables 9 and 10. Table 9 lists the cases where the ratio of transverse (or lateral) stress over the vertical stress reaches the highest value. Table 10 does so for the longitudinal stress. In these tables, negative stress values may occur, since the sign only indicates the direction of the stress and not its magnitude.

TABLE 9: **MAXIMUM RATIOS BETWEEN THE MAXIMUM (PEAK) TRANSVERSE STRESS RELATIVE TO THE MEASURED MAXIMUM VERTICAL CONTACT STRESS (TAKEN AS 10).**

TEST AND TYRE CONDITION RATIOS:	VERTICAL STRESS σ_{zz}	TRANSVERSE (or LATERAL) STRESS τ_{zy}	LONGITUDINAL STRESS τ_{zx}
HVS CREEP SPEED (LINTRACK OLD TYRE) NOSC11A, 100 kN@1100 kPa	10.00 (1815 kPa)	1.95 (354 kPa)	1.53 (277 kPa)
HVS TRAFFIC SPEED (LINTRACK OLD TYRE) NOST52A, 25 kN@500 kPa	10.00 (1138 kPa)	1.92 (218 kPa)	1.21 (138 kPa)
TYRE DIFFERENTIAL WEAR (LINTRACK OLD TYRE) NOSC97E, pnt 5	10.00 (1880 kPa)	1.28 (241 kPa)	1.28 (-241 kPa)
NO DIFFERENTIAL WEAR (LINTRACK OLD TYRE) NOSC97I, pnt 4	10.00 (1627 kPa)	1.97 (320 kPa)	1.28 (208 kPa)
MOVE TRANSVERSE (LINTRACK OLD TYRE) NOSC97P, 5 mm shift	10.00 (1637 kPa)	1.86 (305 kPa)	1.16 (190 kPa)
TILT OR CAMBER (LINTRACK OLD TYRE) NOLC97A, 2% tilt	10.00 (1621 kPa)	1.61 (262 kPa)	1.20 (-194 kPa)
HVS CREEP SPEED (LINTRACK NEW TYRE) NNSC95C, 50 kN @ 950 kPa	10.00 (1577 kPa)	1.75 (277 kPa)	0.80 (-126 kPa)
HVS TRAFFIC SPEED (LINTRACK NEW TYRE) NNST97A, 75 kN @ 950 kPa	10.00 (1688 kPa)	1.86 (313 kPa)	1.33 (-224 kPa)
MOVE TRANSVERSE (LINTRACK NEW TYRE) NNSC97Q, 10 mm shift	10.00 (1620 kPa)	1.86 (301 kPa)	1.42 (-230 kPa)
TILT OR CAMBER (LINTRACK NEW TYRE) NNLC97B, 3% tilt	10.00 (1693 kPa)	1.70 (288 kPa)	1.26 (214 kPa)
HVS CREEP SPEED (LINTRACK OLD TYRE buffed to 1.5 mm groove depth) TNSC57A, 75 kN @ 500 kPa	10.00 (1689 kPa)	2.27 (-383 kPa)	1.48 (-250 kPa)
HVS CREEP SPEED (LINTRACK OLD TYRE buffed to 0 mm groove depth) T2OC57B, 75 kN @ 500 kPa	10.00 (1507 kPa)	2.59 (-390 kPa)	2.05 (308 kPa)

TABLE 10: MAXIMUM RATIOS BETWEEN THE MAXIMUM (PEAK) LONGITUDINAL STRESS RELATIVE TO THE MEASURED MAXIMUM VERTICAL CONTACT STRESS (TAKEN AS 10).

TEST AND TYRE CONDITION RATIOS:	VERTICAL STRESS σ_{zz}	TRANSVERSE (or LATERAL) STRESS τ_{zy}	LONGITUDINAL STRESS τ_{zx}
HVS CREEP SPEED (LINTRACK OLD TYRE) NOSC57C, 75 kN@500 kPa	10.00 (1439 kPa)	1.55 (223 kPa)	2.68 (385 kPa)
HVS TRAFFIC SPEED (LINTRACK OLD TYRE) NOST57B, 75 kN@500 kPa	10.00 (1481 kPa)	1.39 (206 kPa)	2.59 (383 kPa)
TYRE DIFFERENTIAL WEAR (LINTRACK OLD TYRE) NOSC97J, pnt 5	10.00 (1870 kPa)	1.16 (217 kPa)	1.32 (247 kPa)
NO DIFFERENTIAL WEAR (LINTRACK OLD TYRE) NOSC97O, pnt 3	10.00 (1641 kPa)	1.42 (232 kPa)	1.41 (-231 kPa)
MOVE TRANSVERSE (LINTRACK OLD TYRE) NOSC97W, 15 mm shift	10.00 (1544 kPa)	1.44 (222 kPa)	1.33 (-206 kPa)
TILT OR CAMBER (LINTRACK OLD TYRE) NOLC97F, 4% tilt	10.00 (1657 kPa)	1.53 (254 kPa)	1.50 (249 kPa)
HVS CREEP SPEED (LINTRACK NEW TYRE) NNSC57C, 75 kN @ 500 kPa	10.00 (1633 kPa)	1.53 (250 kPa)	1.83 (-298 kPa)
HVS TRAFFIC SPEED (LINTRACK NEW TYRE) NNST57C, 75 kN @ 500 kPa	10.00 (1702 kPa)	1.02 (174 kPa)	1.79 (-305 kPa)
MOVE TRANSVERSE (LINTRACK NEW TYRE) NNSC97U, 15 mm shift	10.00 (1548 kPa)	1.60 (248 kPa)	1.49 (-231 kPa)
TILT OR CAMBER (LINTRACK NEW TYRE) NNLC97B, 3% tilt	10.00 (1693 kPa)	1.70 (288 kPa)	1.26 (214 kPa)
HVS CREEP SPEED (LINTRACK OLD TYRE buffed to 1.5 mm groove depth) TNSC57B, 75 kN @ 500 kPa	10.00 (1675 kPa)	2.22 (-372 kPa)	1.49 (-249 kPa)
HVS CREEP SPEED (LINTRACK OLD TYRE buffed to 0 mm groove depth) T2OC71A, 100 kN @ 700 kPa	10.00 (1771 kPa)	1.96 (-347 kPa)	2.20 (390 kPa)

Tables 9 and 10 show that the maximum stress ratios for **individual** combinations of wheel load and tyre inflation pressure can be much higher than the average values from Tables 7 and 8 and reach ratio values of up to 10 : 2,7 : 2,0.

9.2 Transverse (cross) profile of the buffed down tyre

It was also observed for the buffed down tyres that the shape of the cross profile of the tyre determines to a large extent the shape of the cross section (transverse cross section) of the vertical contact stress distribution. It should be noted here that the transverse profile (i.e. radius) of the tyre buffed down *to aim for an average tread groove depth of 1,5 mm* transversely across the tyre was *different* from the transverse profile of the fully buffed down tyre. This occurred because of a limiting radius on the buffing apparatus which could only buff the tyre to a maximum radius of 876 mm (34,5 inches), which was smaller than the approximate value of 1 117 mm (approximately 44 inches), apparently prescribed for the buffing of wide base tyres.

In order to obtain an average tread groove depth of 1,5 mm, manipulation of the buffing apparatus was necessary in the centre portion of the tyre transverse surface, which resulted in a relatively flat area between the two outer grooves of the tyre. It is therefore quite possible that this might have influenced the magnitude of the transverse stresses at the tyre edges.
This could also explain the smaller ratio value for the edge stresses for both the buffed down cases. This aspect of the influence of the transverse (or cross) profile shape on the 3-D stress at the tyre/pavement interface warrants further investigation.

9.3 Influence of measured transverse (or lateral) stresses of the wide base tyres measured here

Although the measured stresses should be analysed in more detail, a very tentative observation is that, owing to the ***relatively moderate peak transverse stresses found*** for the two tyres tested in the different modes *it is doubtful whether this component alone could be responsible for the development of large enough transverse tensile strains close to the tyre edge which may lead to longitudinal fatigue cracking starting at the surface of the asphalt layers as reported in the Netherlands.* The total 3-D stress conditions should, however, be used in a thorough pavement analysis in order to study the problem of load/stress associated longitudinal cracking (from the surface) in greater detail.

10. SUMMARY OF RESULTS AND DISCUSSION

All the results planned for this test series were analysed to a level where graphical representations could be made of one repetition of a typical test condition, as defined earlier. These results are presented in several of the Appendices to this report. The raw data results of all three test repeats per test condition are available separately in the form of spreadsheet files on a set of nine (9) diskettes in a zipped file format.

The 3-D graphical data representations are given in series of Vertical/Transverse/Longitudinal stresses for each condition tested (ie Z:Y:X). The vertical stresses are plotted to a maximum scale of 2 000 kPa, and both the transverse and longitudinal stresses on a scale of - 400 kPa to + 400 kPa.

A cursory scan through the graphical data was made for the purposes of this report. The observations are qualitative and do not represent final answers, but are intended to guide the user(s) of these data towards more quantitative conclusions that could be made in the future.

(a) Vertical Stress distributions:

From the graphical data presented here (in the various Appendices) the following qualitative observations were made:

- The vertical contact stress distributions are close to those which could be expected under normal load/inflation pressure conditions (i.e. maximum stresses occur mostly at the tyre centre up to loads reaching 75 kN at the higher inflation pressures). However, for relatively low inflation pressures and higher loads the maximum vertical stress shifts to the tyre edges, similar to what was found for bias/cross ply tyres. It is also clear that, the higher the inflation pressure the higher the contact stress at the centre portion of the tyre. Also, the greater te tyre load the greater tyre edge contact stresses. The vertical contact stresses at the tyre edge can be more than twice (x 2) the tyre inflation pressure. This was also evident from the results of both the buffed down cases studied here. It could therefore be postulated that the *tyre inflation pressure* controls most of the vertical stress distribution in the *centre portion* of the wide base single tyre, while the *tyre load* controls the maximum vertical stresses at the *tyre edges* of the wide base single tyres tested here. Detailed analysis should however be done based on the given data to determine these relationships for the purposes of general pavement design guidelines. Similar work and observations were made for the bias/cross ply tyre mentioned earlier [De Beer, 1995b].

- For the treaded tyres the vertical stress distribution is highly irregular ("saw tooth" like) across the width of the tyre, as was expected. This will definitely influence the micro-tyre/pavement interface contact with relatively high shear forces at the edges of the tread ribs around the tyre. For the buffed down tyres, a smoother stress distribution was obtained, also as was expected, based on earlier research on bias/cross ply tyres [De Beer, 1994, 1995b].

- The tyre/pavement contact areas were also measured by the VRSPTA and resemble a very close approximation of the tyre footprints obtained under static loading. For relatively low loads the tyre width is greater than the length of the contact patch but this ratio decreases with increased load to a more square pattern. The tyre width remained constant for almost all tests done here.

- It was demonstrated that up to 4 per cent tilt or camber of the tyre relative to the surface of the VRSPTA has minimal influence on the vertical stress distribution across the tyre. However, the maximum stress moves somewhat to the side of the tyre closest to the contact surface.

- It was also demonstrated that the *sideways shear* predominantly controls the magnitude and shape of the *additional* transverse stress components developing across the wide base single tyres during cornering.

- Another important observation was made with regard to the magnitude of differential local wear on individual ribs of the old Lintrack tyre. Wear of up to a depth 6 mm was found in certain areas and the vertical contact stresses measured here indicated that the magnitude of the vertical stress in this area could reduce to approximately 30 per cent to 50 per cent of the maximum stress in the area without wear. This type of irregular local tyre wear will undoubtedly result in relatively high dynamic stresses (especially shear) in the region close to the pavement surface. The full effect of this should be investigated further.

(b) Transverse (Lateral) Stress distributions:

- On both the buffed down and smooth tyres, the transverse stress distributions showed both inward and outward directions, especially at the higher loads. The outward transverse stresses are mainly associated with the higher tyre inflation pressures ($\geq$ 900 - 950 kPa), whilst the inward stresses are mostly associated with the lower tyre inflation pressures.

- For the tyres with tread grooves the transverse stress distributions are also more "saw tooth" like and are highly irregular. No obvious evidence of *inward vs outward* stress reversals was noted here. It seems that each *individual rib* appears to act like a smooth tyre on its own, producing contact stress reversals (i.e. positive and negative stresses).

(c) Longitudinal Stress distributions:

- For the buffed down tyres the basic pattern showed some stress reversals towards the tail end of the tyre patch. This is especially true at the tyre edges, and is quite evident at low inflation pressures and relatively high loads.

- For the tyres with tread grooves, it seems that each rib acts on its own like a "smooth" tyre, with the stress reversals evident on more areas inside the tyre patch than at the outside edges of the tyre. This appears also to be more evident at relatively higher wheel loads.

(d) Special test conditions:

- The most dramatic influence on the shape of the stress distributions was found on the tyre with tread grooves tested with "sideways shear". This is especially true for the vertical and transverse stress measured, which increase during this action.

- The tilting to approximately 4 per cent, testing at different circumferential positions and at different cross positions on the VRSPTA did not significantly influence the shape of all the stress distributions obtained, other than that more irregular vertical distributions associated with local wear patches were found on some individual ribs on the old Lintrack tyre.

11. CONCLUSIONS

From the research described in this report, the following can be concluded:

- The current VRSPTA system was used very successfully for a very extensive series of tyre/pavement interface testing done in the field under the Heavy Vehicle Simulator (HVS) in South Africa. A raw data base now exists on the two Lintrack tyres, which may be used for further in-depth analysis of its effects on pavement deterioration and behaviour under the various loading and tyre inflation pressure conditions.

- Tyre/pavement contact stresses under wide base single tyres were successfully measured under loads ranging from 25 kN to 100 kN and tyre inflation pressures ranging from 500 kPa to 1100 kPa.

- Both the systematic and some random errors associated with VRSPTA system used here have been quantified, and indicated acceptable levels of less than 10 per cent under field conditions.

- The measured stresses were found to be quite different from the load model (circular uniform vertical pressure, equal to the tyre pressure, with no horizontal stresses), generally used to define the load/stresses as inputs into current pavement analysis methods. The new data given here show, amongst others, that the contact area of wide base tyres is more rectangular compared to the traditional bias/cross ply tyres and, that the vertical contact stresses may be more than twice as high as the tyre inflation pressure. The vertical stresses are clearly distributed differently in the centre zone than in the edge zone across the tyre width, and considerable shear stresses occur, in some cases of the same order of magnitude as the tyre inflation pressure. Furthermore, the distribution of transverse stresses of normal tyres (with the tread grooves) is highly irregular, and more like a "saw tooth" effect. These differences, compared to the old load model, may be much larger than the possible measurement inaccuracies of the VRSPTA system used in this study.

- Local wear on tyres and on individual tread ribs was clearly demonstrated to have a major influence, especially on the vertical stress distribution across the tyre width.

- There appear to be large differences between the stress distributions on tyres with tread grooves (patterns) and those with buffed down (i.e. smooth) contact surfaces. Thus the shape and condition of the tyre cross section to a large extent dictates the distribution of the contact stresses at a full friction tyre/pavement interface.

- All tests were done at relatively low speeds from approximately 0,26 m/s (1 km/h) to approximately 4,5 m/s (16 km/h). The effects of higher speeds on these tyres are therefore unclear. Based on the possibility of centrifugal forces at relatively high wheel speeds resulting in so-called "axle lift" it is postulated that an increase in speed may result in increased vertical contact stress at the centre portion of the tyre. Therefore the tyre edge stresses may be reduced at these higher speeds. Local tyre wear in the centre portion of the tyre however, may counteract this effect.

- Sideways shear seems to dominate transverse (lateral) stress components. This should be investigated further for implications at the slow speed cornering of heavy vehicles.

- Tilt and camber also play a role on the contact stresses at the tyre/pavement interface. However, the results given here did not show that this was qualitatively significant within the constraints of the testing discussed.

- As for bias/cross ply truck tyres studied earlier [De Beer, 1994], it seems that the data qualitatively indicate that the tyre/pavement contact stresses at the tyre centre portion of wide base single tyres are largely controlled by tyre inflation pressures, whilst the contact stresses at the tyre edges are predominantly controlled by the tyre loading. Therefore, if properly quantified, two basic design functions may result, converting either inflation pressure to contact stress at the centre of the tyre contact patch, or loading to tyre edge contact stress. The effect of speed on the vertical stress at the tyre centre portion, however, should also be included for advanced modelling based on the foregoing.

- The investigation of all the results grouped togehter indicated that the **average** ratios between maximum (peak) stress and the transverse (or lateral) stress are much lower than expected. The average ratio found between the **Vertical: Transverse: Longitudinal stresses** is: **10 : 1,5 : 1,0**. This is *much lower* than that found in similar studies on bias/cross ply tyres, which resulted in transverse stresses of up to 3 or 4 times than those found in the free rolling mode. However, when the data is divided into sub-groups the **maximum (peak)** stress ratios reached values up to **10 : 2,7 : 2,0.** It was also found that the transverse stress component of the wide base single tyres increased roughly 2.5 times under sideways shear compared to the free rolling case investigated here.

- Although the measured stresses should be further analysed in more detail, a tentative observation is that owing to the ***relatively low peak transverse stresses found*** for the two tyres tested in the different modes *it is doubtful whether this component alone could be responsible for the development of large enough transverse tensile strains close to the tyre edge which may lead to longitudinal fatigue cracking starting at the surface of the asphalt layers in the Netherlands.* The total 3-D stress conditions should, however, be used in a thorough pavement analysis in order to study the problem of load/stress associated longitudinal cracking (from the surface) in greater detail.

- The effects of driving forces and braking forces on wide base single tyres were not studied here. It is strongly recommended that studies similar to that described here should be carried out on these aspects.

- Successful international co-operation in a common research project was adequately demonstrated by this project.

12. RECOMMENDATIONS

Based on the experience and results gained from this study, the following aspects are recommended for future research:

- Pavement analysis tools should be developed to include a definition for the 3-D stress pattern found for pneumatic tyres in order to effectively define the load/stress input(s) for design purposes;

- The effects of increased tyre speed, driving and braking, together with the associated dynamic loading effects of tyres should receive greater emphasis in future studies of this nature;

- The results given in this report should be analysed further in order to define future steps to be taken with regard to improved pavement design, pavement monitoring, maintenance scheduling and pavement analysis. This should be focussed on both relatively thin asphalt layers and the thicker asphalt layers found in flexible pavements;

- The VRSPTA system may serve as a basis for the development of future "Stress-In-Motion" (SIM) systems to complement currently available "Weigh-In-Motion" (WIM) systems. This will ultimately lead to a data base of contact stress patterns and "load/stress-per-wheel" patterns to be defined for the heavier traffic on road systems. Such information could be used not only for potential traffic control but also for improved design and maintenance of pavements. Future traffic load/stress regulatory legislation may also follow from data collected with such a SIM system. This, however, should be practically achievable to ensure effective implementation of laws intended to protect the road infrastructure. However, it is clear from the research done so far with the VRSPTA system that the tyre/pavement contact stress could play a vital role in the structural and functional performance of flexible pavement structures.

- A feasibility study to investigate future SIM systems, preferably more simplified than the VRSPTA system described in this report, should be carried out.

13. REFERENCES

BOUMAN, S.R., Molenaar, A.A.A., van Gurp C.A.P.M. and Vogelzang, C.H. (1991). **Lintrack response measurements, comparison of measured asphalt strains and predicted values, part I measuring report and part II interpretation report** (in Dutch); Reports 7-91-209-17 and 7-91-209-18; Delft University of Technology, Faculty of Civil Engineering; Delft, NL.

CRONEY, D. and Croney P. (1991). **The design and performance of road pavements. 2nd Edition:** Maidenhead, UK: McGraw-Hill.

DE BEER, M., Horak, E. (1987). The effect of poor drainage on pavement structures studied under accelerated testing. In: **Proceedings of the Annual Transportation Convention [ATC 1987],** Vol. 5B, Pretoria, South Africa, August 1987.

DE BEER, M., Horak, E. and Visser, A.T. (1988). The multi-depth deflectometer (MDD) system for determining the effective elastic moduli of pavement layers. In: **First international symposium on non-destructive testing of pavements and back calculation of moduli.** Baltimore, USA, 26 June to 1 July 1988.

DE BEER, M. (1991) Pavement response measuring system. In: **Second international symposium on pavement response monitoring systems for roads and airfields. Collection and analysis of field data.** Hanover, New Hampshire, USA, 6 to 9 September 1991.

DE BEER, M. (1994). **Measurement of tyre/pavement interface stresses under moving wheel loads.** Research Report DPVT 224 (Revised), Pavement Engineering Technology, Division of Roads and Transport Technology, CSIR, April 1994.

DE BEER, M. (1995a). **Tyre/pavement interface stresses measured with the Vehicle-Road Surface Pressure Transducer Array (VRSPTA) system (i.e. "3-D Loadcell"); Part I: The VRSPTA system: some technical detail.** (Unpublished Confidential Technical Note I/PA/11/95, Pavement Engineering Technology), Pretoria: Division of Roads and Transport Technology, CSIR, 1995.

DE BEER, M. (1995b). **Tyre/pavement interface stresses measured with the Vehicle-Road Surface Pressure Transducer Array (VRSPTA) system (i.e. "3-D Loadcell"); Part II: Data analysis: vertical stress.** (Unpublished Technical Note I/PA/12/95, Pavement Engineering Technology), Pretoria: Division of Roads and Transport Technology, CSIR, 1995.

DE JONG, D.L., Peutz M.G.F., and Korswagen A.R. (1973). **Computer Program Bisar.** External Report AMSR.0006.73, Royal/ Shell Laboratory, Amsterdam.

FREEME, C.R., Meyer, R.G. and Shackel, B. (1981). A method for assessing the adequacy of road pavement structures using a Heavy Vehicle Simulator. In: **Proceedings of the 9th IRF world meeting,** Stockholm, June 1981, Vol. T55, pp 151 - 167.

FREEME, C.R., Maree, J.H. and Viljoen, A.W. (1982a). Mechanistic design of asphalt pavements and verification of designs using the Heavy Vehicle Simulator. In: **Proceedings of the 5th international conference on the structural design of asphalt pavements.** Vol. 1, pp 156 - 173, Delft, Netherlands, 1982.

FREEME, C.R., Maree, J.H. and Walker, R.N. (1982b). **Users experience with the South African Heavy Vehicle Simulators.** Proceedings of the Conference on bearing capacity of roads and airfields, Vol. II, The Norwegian Institute of Technology, Norway, 1982.

FREEME, C.R., Servas, V.P. and Walker, R.N. (1984). Pavement behaviour from Heavy Vehicle Simulator results. In: **Proceedings of the Annual Transportation Convention [ATC 1984]**, 6 to 9 August 1984, Pretoria, South Africa.

FREEME, C.R., De Beer, M. and Viljoen, A.W. (1987). The behaviour and mechanistic design of asphalt pavements. In: **Proceedings of the 6th international conference on the structural design of pavements**, Vol. 1, Ann Arbor, Michigan, July 1987.

GROENENDIJK, J., Vogelzang, C.H., Molenaar, A.A.A., and Dohmen, L.J.M. (1994). Performance tests under accelerated loading with the Lintrack test facility in the Netherlands; In: **Proceedings of the 4th International Conference on the bearing capacity of roads and airfields [BCRA]**, Minneapolis, MN, USA, 1994, Vol. 2; University of Minnesota; pp. 1163 - 1179; Minneapolis, MN, USA.

GROENENDIJK, J., Vogelzang, C.H., Miradi, A., Molenaar, A.A.A, and Dohmen, L.J.M. (1996a); **Results of the Lintrack performance tests on a full-depth asphalt pavement;** (Paper submitted for 1997 Annual TRB Meeting; Delft University of Technology, Delft, NL)

GROENENDIJK, J., Vogelzang, C.H., Miradi, A., Molenaar, A.A.A, and Dohmen, L.J.M. (1996b); **Rutting development in Lintrack test pavements: evaluation of the Shell subgrade strain criterion;** (Paper submitted for 1997 Annual TRB Meeting; Delft University of Technology, Delft, NL).

GROENENDIJK, J. (1996). Personal Communication with M De Beer, during post-analysis of the contact stress measurements discussed in this report, fax dated August 20, 1996 (4 pages).

HORAK, E., Kleyn, E.G., du Plessis, J.A., de Villiers, E.M. and Thompson, A.J. (1992); The Impact of the Heavy Vehicle Simulator (HVS) fleet in South Africa; In: **Proceedings of the 7th International Conference on Asphalt Pavements [ISAP]**, Performance Volume 2, August, 1992, pp 134 - 150, Nottingham, UK.

JACOBS, M.M.J. and Moraal, J. (1992); **The influence of tyre characteristics on the normal stresses in asphalt concrete pavements**; Heavy vehicles and roads: technology, safety and policy. Edited by D. Cebon and C.G.B. Mitchell; Thomas Telford; pp. 218 - 224; London, UK.

KIRKPATRICK, E.G. (1974). **Introductory Statistics and Probability for Engineering, Science, and Technology.** Prentice- Hall, Inc., Englewood Cliffs, New Jersey.

MANTE, B.R., Molenaar, A.A.A., and Groenendijk, J. (1995); **Stresses and strain in pavements - LINTRACK response measurements: identification of damaging effects of several wheel-load configurations, part 1 main report and part 2, measurement data and appendices**; Reports 7-95-209-33M and 7-95-209-34M; Delft University of Technology, Faculty of Civil Engineering; Delft, NL.

MAREE, J.H., Freeme, C.R., Van Zyl, N.J.W. and Savage, P.F. (1982). The permanent deformation of pavements with untreated crushed stone bases as measured in Heavy Vehicle Simulator tests. In: **Proceedings of the 22nd ARRB conference**, Vol. 2, 1982.

MATLAB (1996). **Matrix Laboratory, High Performance Numeric Computation and Visualization Software. Users Guide.** The Mathworks Inc.Natrick Mass., USA.

ROAD NOTE 27. (1960). **Instructions for using the Portable Skid-Resistance Tester**. Road Research Laboratory, HMSO, London, 1960.

ROAD AND HYDRAULIC ENGINEERING DIVISION OF THE DUTCH MINISTRY OF TRANSPORT, PUBLIC WORKS AND WATER MANAGEMENT (RHED) (1994). **Pavement Design Guide.** Ministry of Transport, Public Works and Water Management, Delft, NL.

SAATHOF, L.E.B. and Henny, R.J. (1992); **Axle loads over roads** (in Dutch); Wegbouwkundige Werkdagen 1992, Publikatie 60-I; C.R.O.W.; pp. 57 - 66; Ede, NL.

TIMOSHENKO, S.P. and Goodier, J.N. (1970). **Theory of elasticity** (3rd edition), International student edition, Mc-Graw-Hill, 1970.

WALKER, R.N., Paterson, W.D.O., Freeme, C.R. and Marais, C.P. (1977). The South African mechanistic pavement design procedure. In: **Proceedings of the fourth international conference on structural design of asphalt pavements**, Vol. 2, Ann Arbor, Michigan, USA, 1977.

WOODSIDE, A.R., Wilson, J. and Guo Xin Liu (1992). The distribution of stresses at the interface between tyre and road and their effect on surface chippings. In: **Proceedings of the 7th International Conference on Asphalt Pavements [ISAP]**, Design and Performance Volume 3, August, 1992, pp 428 - 442, Nottingham, UK.

APPENDIX A:

3-DIMENSIONAL (3-D) PLOTS OF STRESSES MEASURED UNDER THE LINTRACK *USED* BRIDGESTONE 425/65 R 22.5 R160AZ TYRE AT "CREEP SPEED"

TABLE 1: HVS4: 3D Stress Sensor Tests on the used(old) Bridgestone R160AZ 425/65 R22.5 PR20 tyre

Legend of filename with tests on OLD (used) tyre : NOSC92AZ.PRN : **CREEP TESTS**

N=Netherlands ; O=Lintrack (Old or used tyre) ; S=Super single ; C=Creep speed;(or T=Traffic (HVS) speed) ;

9=Cold inflation pressure 950 kPa ; 2=Vertical load 25 kN : A=Test (repeat)1 (or B=repeat 2 or C=repeat 3);

Z=Vertical stress (or X=Transverse, or Y=Longitudinal).

DATE 10/06/96

Speed Sensor distance = 1.0m

NETOLD.WK1

HVS POSITION

Traffic side

Traffic side | Cabin end

Caravan side

Filename		PRESSURE	HVS	LOAD BOX	TEMP	SPEED	Hz	Figure	Pin numbers across loadcell										A = ALL DIRECTIONS MISSED THE PIN										3d-Loadcell
*.prn		(kPa)	(kN)	(kN)	°C	(m/s)	(sam/sec)	no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total load (kN)
NOSC52	Az/x/y	500	25	22.1	16	0.322	150	A1	A				A														A	A	22.63
NOSC52	Bz/x/y	500	25	22.1	18	0.318	150	-	A																		A	A	22.45
NOSC52	Cz/x/y	500	25	22.1	18	0.316	150	-	A																		A	A	22.86
NOSC55	Az/x/y	500	50	49.9	18	0.306	150	-	A																		A	A	49.97
NOSC55	Bz/x/y	500	50	48.6	18	0.302	150	-	A																		A	A	49.56
NOSC55	Cz/x/y	500	50	49.2	18	0.303	150	A2	A																		A	A	49.15
NOSC57	Az/x/y	500	75	73.1	18	0.301	150	A3	A														A					A	76.84
NOSC57	Bz/x/y	500	75	73.1	18	0.303	150	-	A														A				Y	A	76.91
NOSC57	Cz/x/y	500	75	73.1	18	0.301	150	-	A														A				Y	A	75.99
NOSC72	Az/x/y	700	25	23.8	18	0.308	150	-	A	A																	A	A	23.77
NOSC72	Bz/x/y	700	25	23.8	18	0.311	150	A4	A	A																	A	A	23.39
NOSC72	Cz/x/y	700	25	23.4	18	0.307	150	-	A	A																	A	A	23.32
NOSC75	Az/x/y	700	50	48.5	19	0.311	150	A5	A																			A	48.63
NOSC75	Bz/x/y	700	50	48.5	19	0.307	150	-	A																			A	48.01
NOSC75	Cz/x/y	700	50	48.5	19	0.310	150	-	A																			A	49.00
NOSC77	Az/x/y	700	75	74.3	19	0.306	150	A6	A																			A	73.75
NOSC77	Bz/x/y	700	75	74.3	19	0.308	150	-	A																			A	74.28
NOSC77	Cz/x/y	700	75	74.0	19	0.309	150	-	A																			A	74.26
NOSC71	Az/x/y	700	100	101.0	19	0.301	150	A7	A																			A	102.11
NOSC71	Bz/x/y	700	100	100.8	19	0.301	150	-	A																			A	102.22
NOSC71	Cz/x/y	700	100	100.5	19	0.300	150	-	A																			A	101.63
NOC902	Az/x/y	900	25	24.9	25	0.305	150	-	A	A																	A	A	22.62
NOC902	Bz/x/y	900	25	24.9	25	0.302	150	-	A	A																	A	A	23.61
NOC902	Cz/x/y	900	25	24.8	25	0.296	150	A8	A	A																	A	A	23.99
NOC905	Az/x/y	900	50	49.0	25	0.298	150	A9	A																			A	45.17
NOC905	Bz/x/y	900	50	48.3	25	0.299	150	-	A																			A	45.63
NOC905	Cz/x/y	900	50	49.1	25	0.298	150	-	A																			A	45.86
NOC907	Az/x/y	900	75	75.1	25	0.305	150	A10	A																			A	77.54
NOC907	Bz/x/y	900	75	75.0	25	0.305	150	-	A																			A	77.57
NOC907	Cz/x/y	900	75	75.0	25	0.303	150	-	A																			A	77.08

TABLE 1 (Cont.): HVS4: 3D Stress Sensor Tests on the used(old) Bridgestone R160AZ 425/65 R22.5 PR20 tyre

Legend of filename with tests on OLD (used) tyre : NOSC92AZ.PRN : CREEP TESTS

N=Netherlands ; O=Lintrack (Old or used tyre) ; S=Super single ; C=Creep speed;(or T=Traffic (HVS) speed) ;

9=Cold inflation pressure 950 kPa ; 2=Vertical load 25 kN : A=Test (repeat)1 (or B=repeat 2 or C=repeat 3);

Z=Vertical stress (or X=Transverse, or Y=Longitudinal).

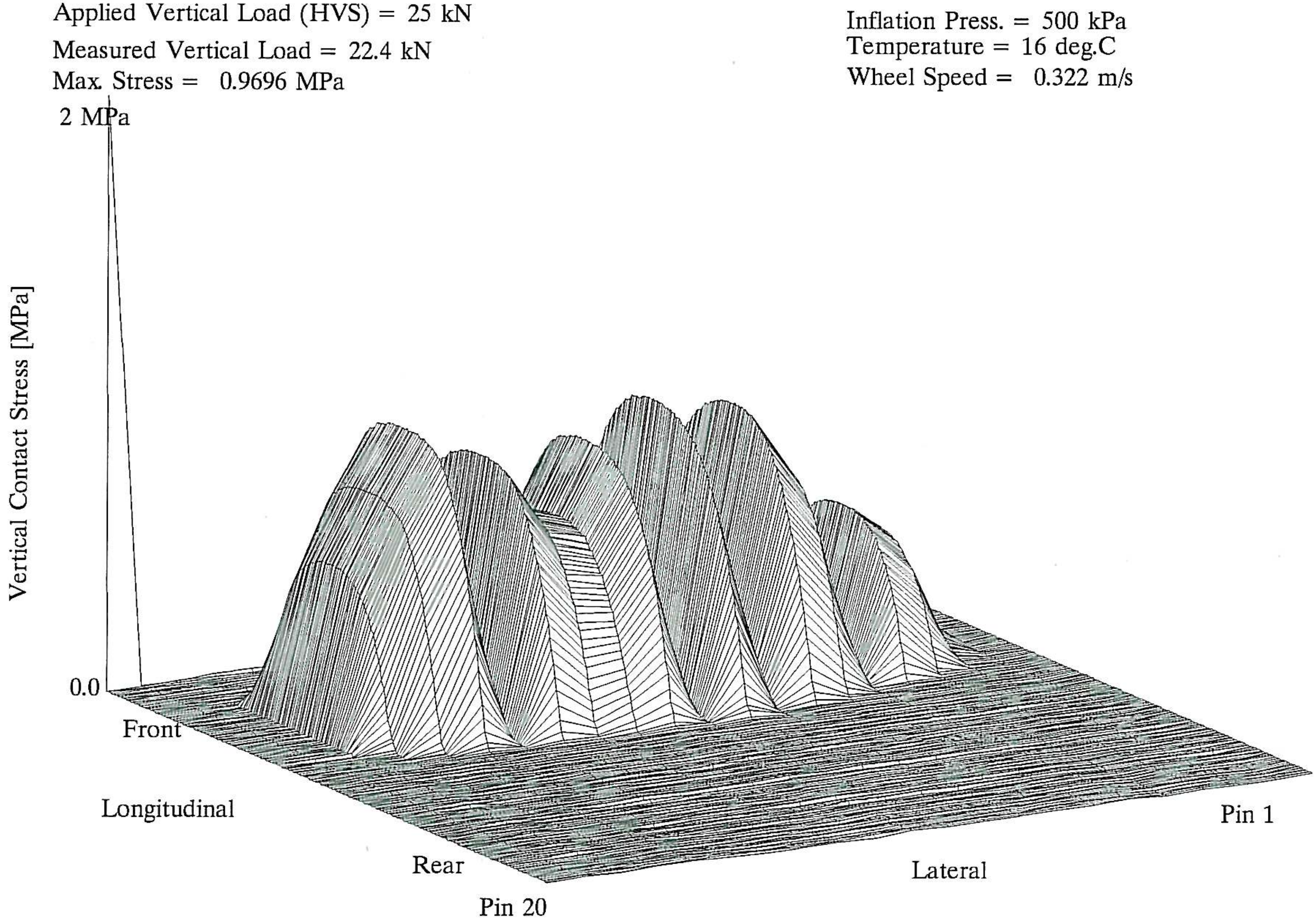
DATE 10/06/96

Speed Sensor distance = 1.0m

NETOLD.WK1

HVS POSITION		
	Traffic side	
Traffic side		Cabin end
	Caravan side	

Filename		PRESSURE	HVS	LOAD BOX	TEMP	SPEED	Hz	Figure	Pin numbers across loadcell A = ALL DIRECTIONS MISSED THE PIN																				3d-Loadcell
*.prn		(kPa)	(kN)	(kN)	°C	(m/s)	(sam/sec)	no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total load (kN)
NOC901	Az/x/y	900	100	99.6	23	0.293	150	A11	A																			A	105.46
NOC901	Bz/x/y	900	100	99.6	23	0.294	150	-	A																			A	105.91
NOC901	Cz/x/y	900	100	99.6	23	0.295	150	-	A																			A	106.00
NOSC92	Az/x/y	950	25	23.8	22	0.291	150	A12	A	A																	A	A	23.77
NOSC92	Bz/x/y	950	25	23.8	22	0.294	150	-	A	A																	A	A	24.81
NOSC92	Cz/x/y	950	25	23.8	22	0.300	150	-	A	A																	A	A	25.92
NOSC95	Az/x/y	950	50	48.2	20	0.296	150	A13	A																			A	46.13
NOSC95	Bz/x/y	950	50	48.3	20	0.297	150	-	A																			A	46.23
NOSC95	Cz/x/y	950	50	48.4	20	0.297	150	-	A																			A	46.08
NOSC97	Az/x/y	950	75	72.5	19	0.309	150	A14	A																			A	75.18
NOSC97	Bz/x/y	950	75	72.5	19	0.311	150	-	A																			A	74.78
NOSC97	Cz/x/y	950	75	72.5	19	0.310	150	-	A																			A	74.64
NOSC91	Az/x/y	950	100	100.3	20	0.300	150	A15	A																			A	100.98
NOSC91	Bz/x/y	950	100	100.1	20	0.300	150	-	A																			A	101.14
NOSC91	Cz/x/y	950	100	100.3	20	0.298	150	-	A																			A	100.47
NOSC12	Az/x/y	1100	25	22.8	16	0.296	150	A16	A	A																	A	A	22.82
NOSC12	Bz/x/y	1100	25	23.8	18	0.286	150	-	A	A	A																A	A	21.98
NOSC12	Cz/x/y	1100	25	23.8	18	0.288	150	-	A	A	A																A	A	21.43
NOSC15	Az/x/y	1100	50	49.5	19	0.281	150	A17	A																			A	47.60
NOSC15	Bz/x/y	1100	50	49.5	19	0.291	150	-	A																			A	50.07
NOSC15	Cz/x/y	1100	50	49.5	19	0.289	150	-	A																			A	48.50
NOSC17	Az/x/y	1100	75	74.8	20	0.286	150	A18	A																			A	73.70
NOSC17	Bz/x/y	1100	75	74.9	20	0.285	150	-	A																			A	72.56
NOSC17	Cz/x/y	1100	75	74.8	20	0.284	150	-	A																			A	72.60
NOSC11	Az/x/y	1100	100	100.5	20	0.291	150	A19	A																			A	102.10
NOSC11	Bz/x/y	1100	100	100.3	20	0.291	150	-	A																			A	101.16
NOSC11	Cz/x/y	1100	100	100.4	20	0.291	150	-	A																			A	99.86



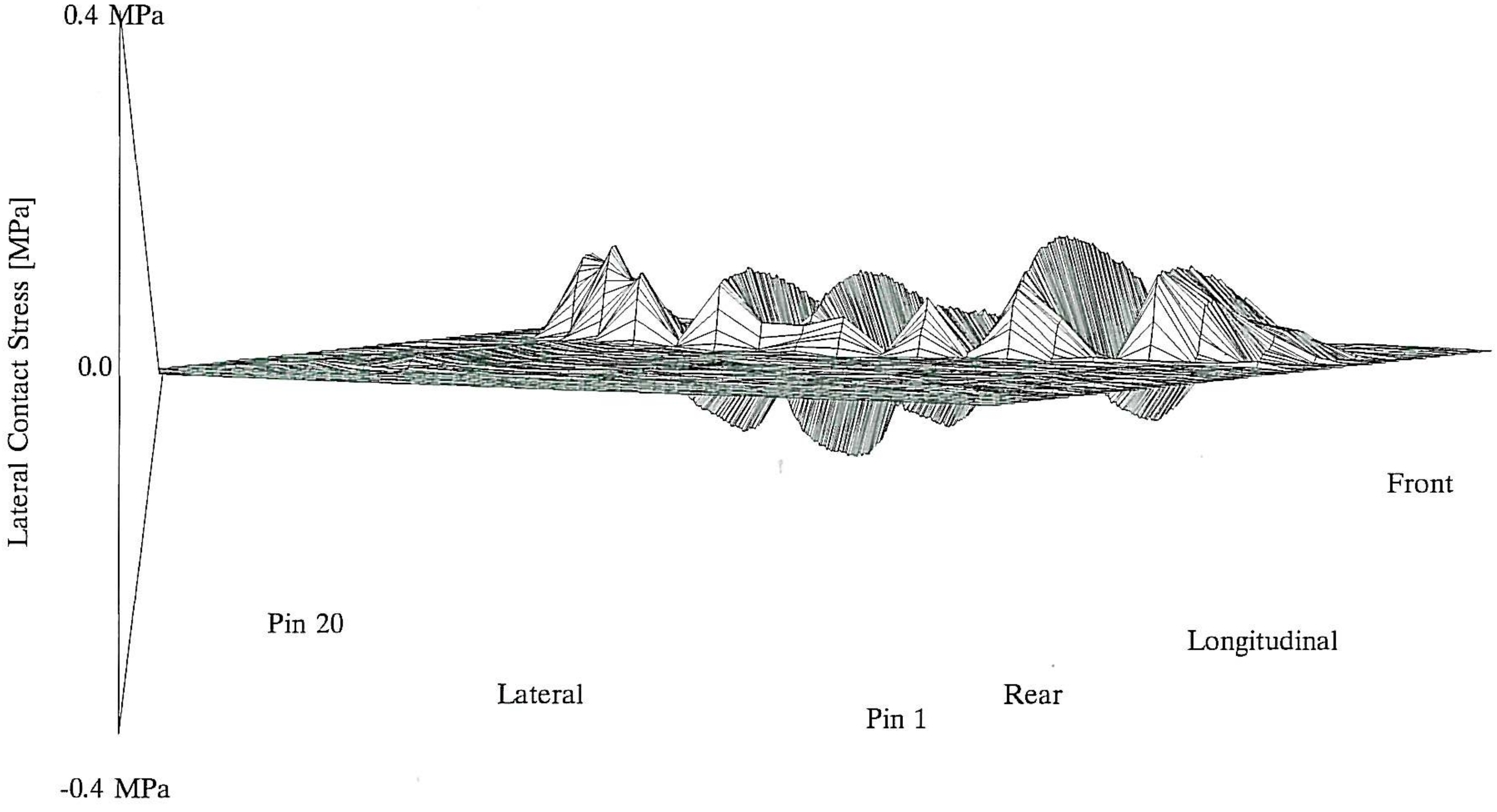
Used Bridgestone 425/65R22.5 R160AZ

Filename : nosc52az

FIGURE A1Z

Applied Vertical Load (HVS) = 25 kN
Measured Lateral Load = 0.5663 kN
Max. Stress = 0.1324 MPa
Min. Stress = -0.1265 MPa

Inflation Press. = 500 kPa
Temperature = 16 deg.C
Wheel Speed = 0.322 m/s



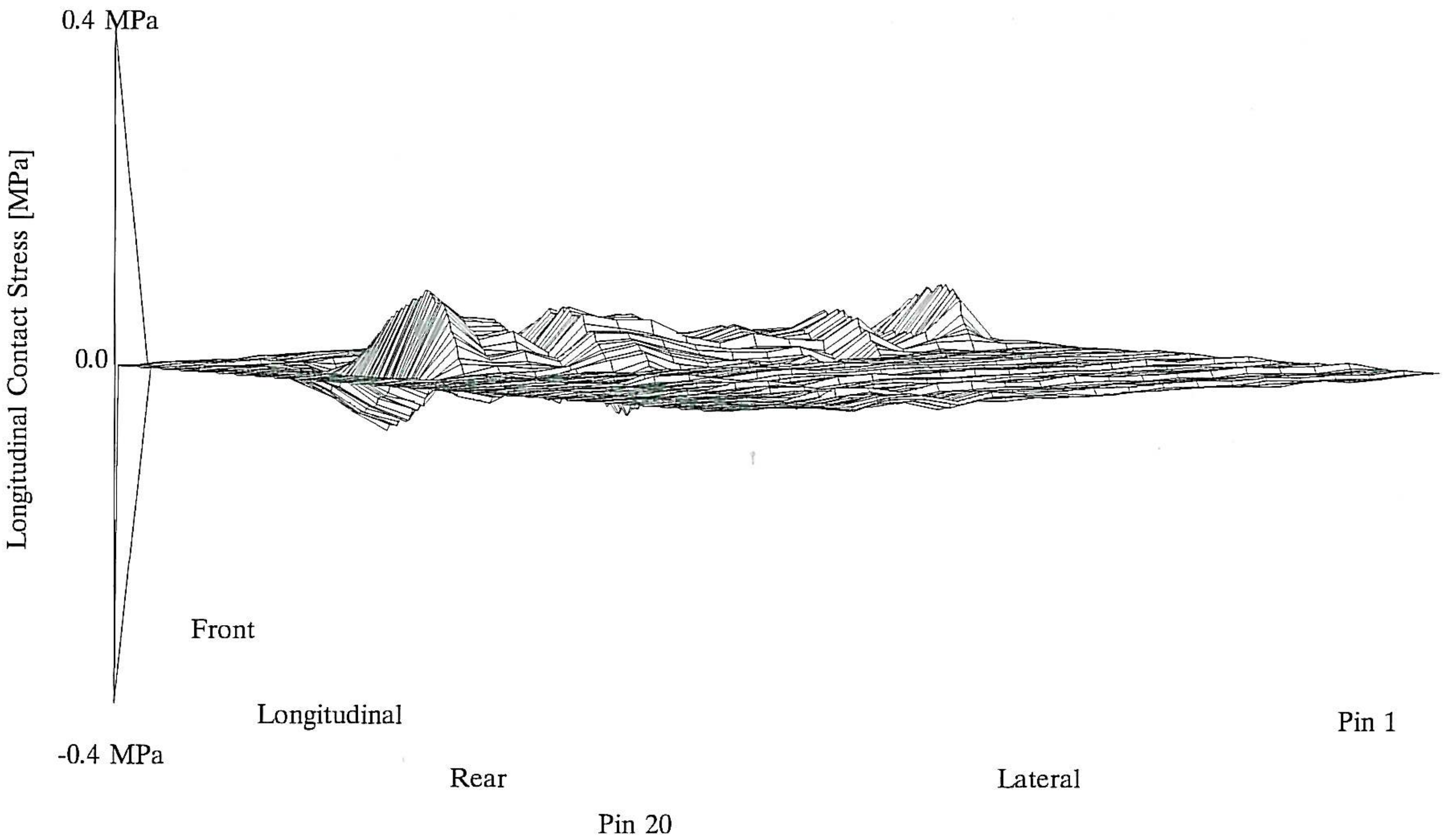
Used Bridgestone 425/65R22.5 R160AZ

FIGURE A1Y

Filename : nosc52ay

Applied Vertical Load (HVS) = 25 kN
Measured Longitudinal Load = 0.234 kN
Max. Stress = 0.1014 MPa
Min. Stress = -0.07883 MPa

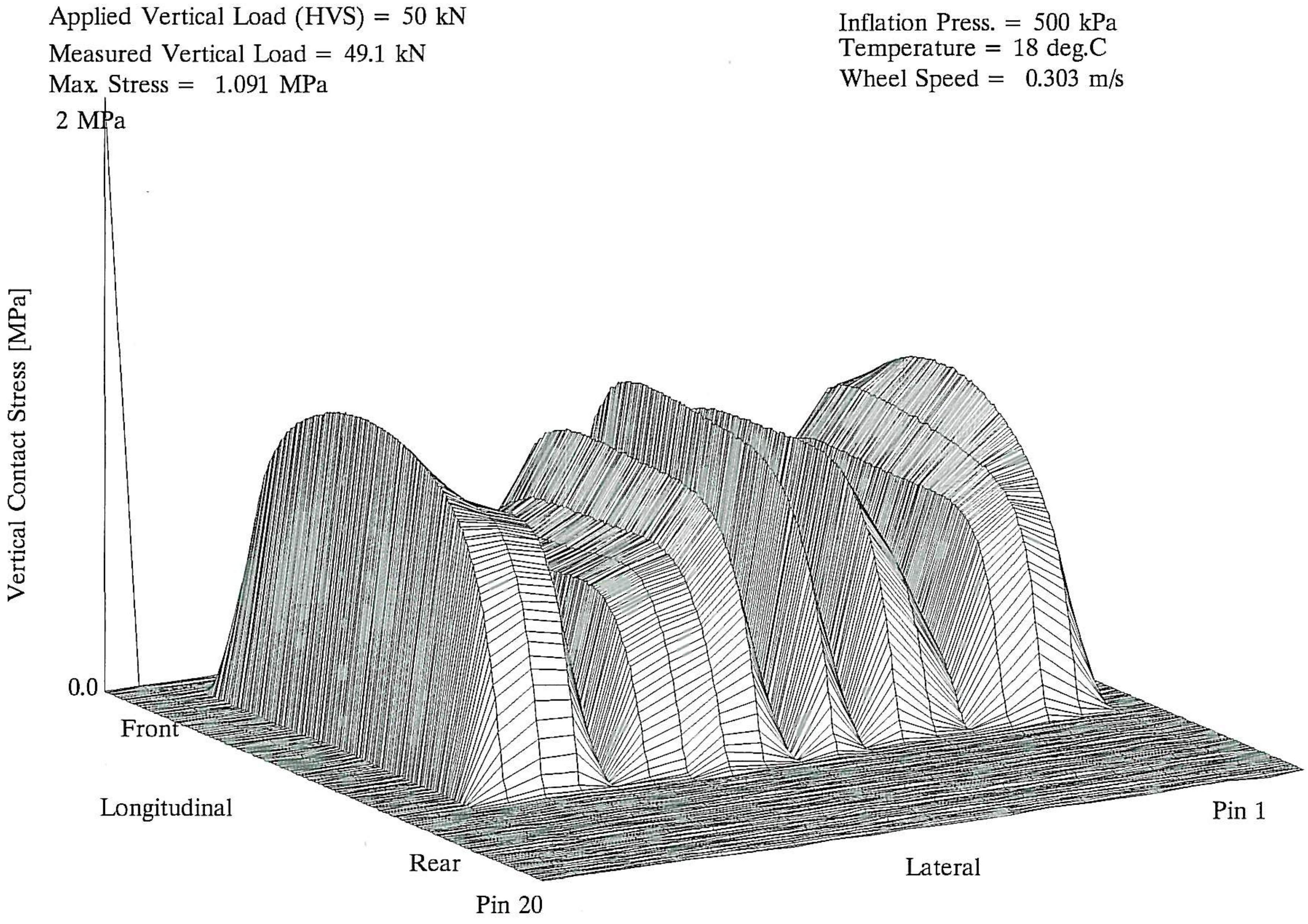
Inflation Press. = 500 kPa
Temperature = 16 deg.C
Wheel Speed = 0.322 m/s



Used Bridgestone 425/65R22.5 R160AZ

Filename : nosc52ax

FIGURE A1X



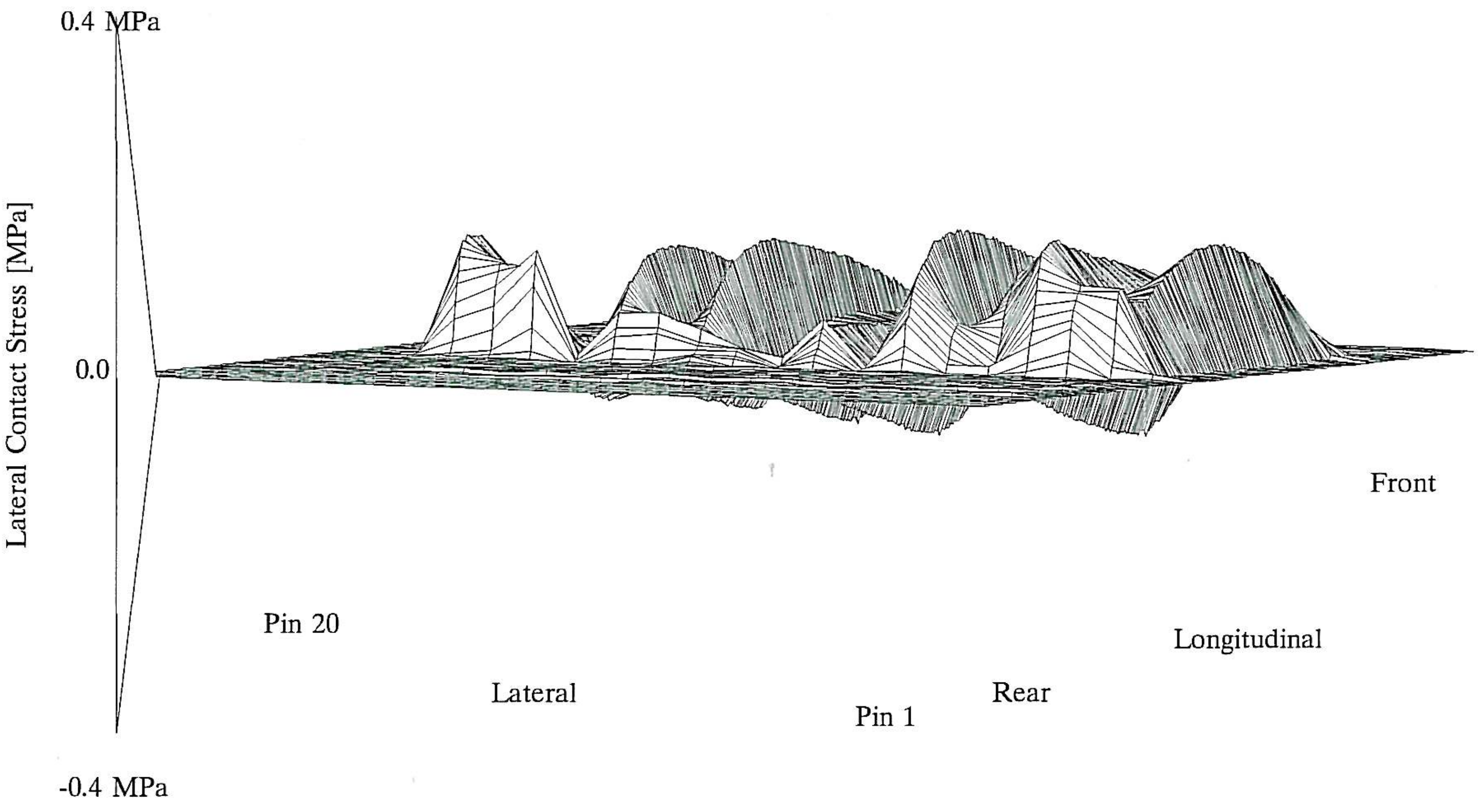
Used Bridgestone 425/65R22.5 R160AZ

Filename : nosc55cz

FIGURE A2Z

Applied Vertical Load (HVS) = 50 kN
Measured Lateral Load = 2.324 kN
Max. Stress = 0.1532 MPa
Min. Stress = -0.1007 MPa

Inflation Press. = 500 kPa
Temperature = 18 deg.C
Wheel Speed = 0.303 m/s



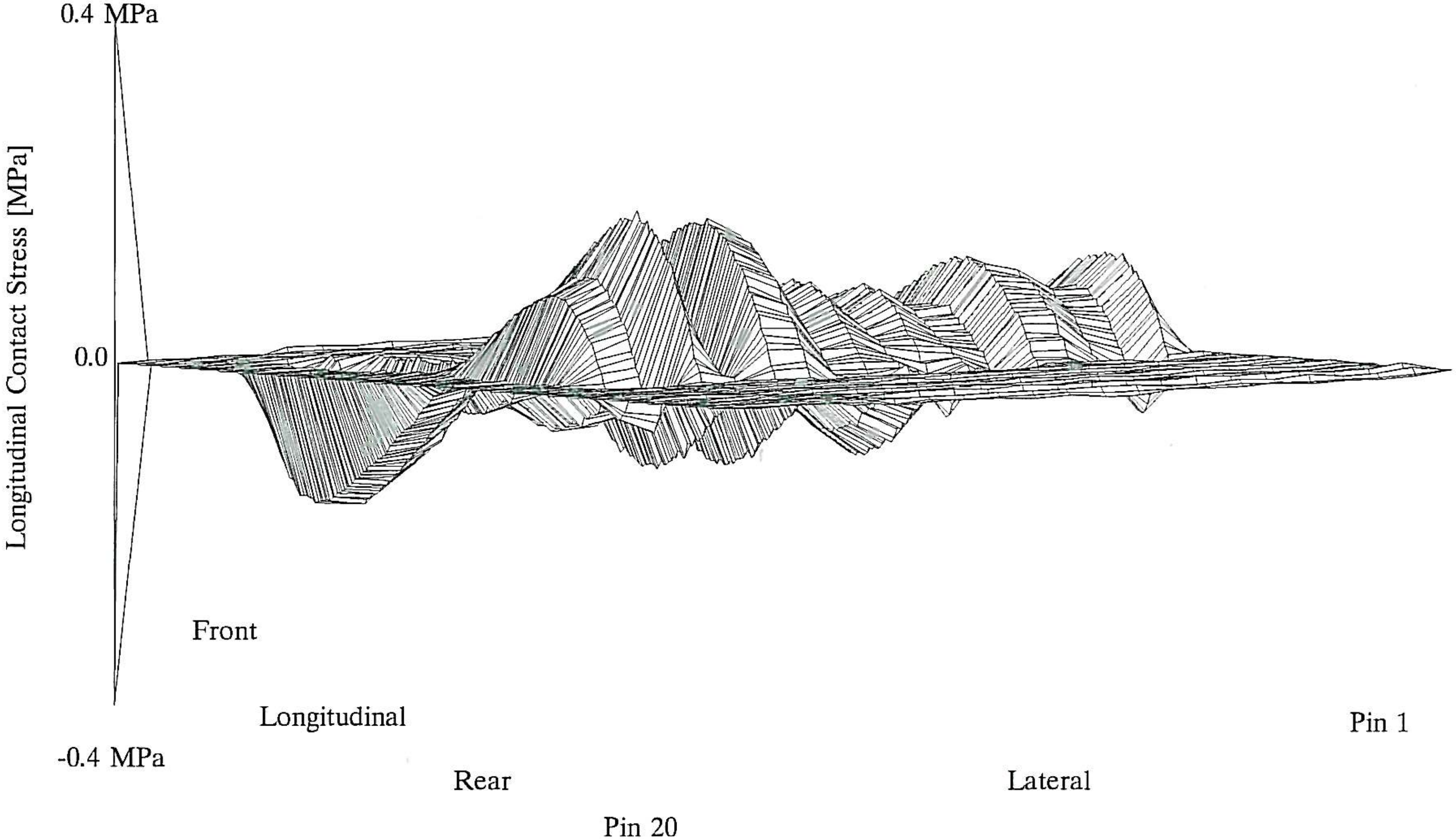
Used Bridgestone 425/65R22.5 R160AZ

FIGURE A2Y

Filename : nosc55cy

Applied Vertical Load (HVS) = 50 kN
Measured Longitudinal Load = 0.5153 kN
Max. Stress = 0.1982 MPa
Min. Stress = -0.1657 MPa

Inflation Press. = 500 kPa
Temperature = 18 deg.C
Wheel Speed = 0.303 m/s



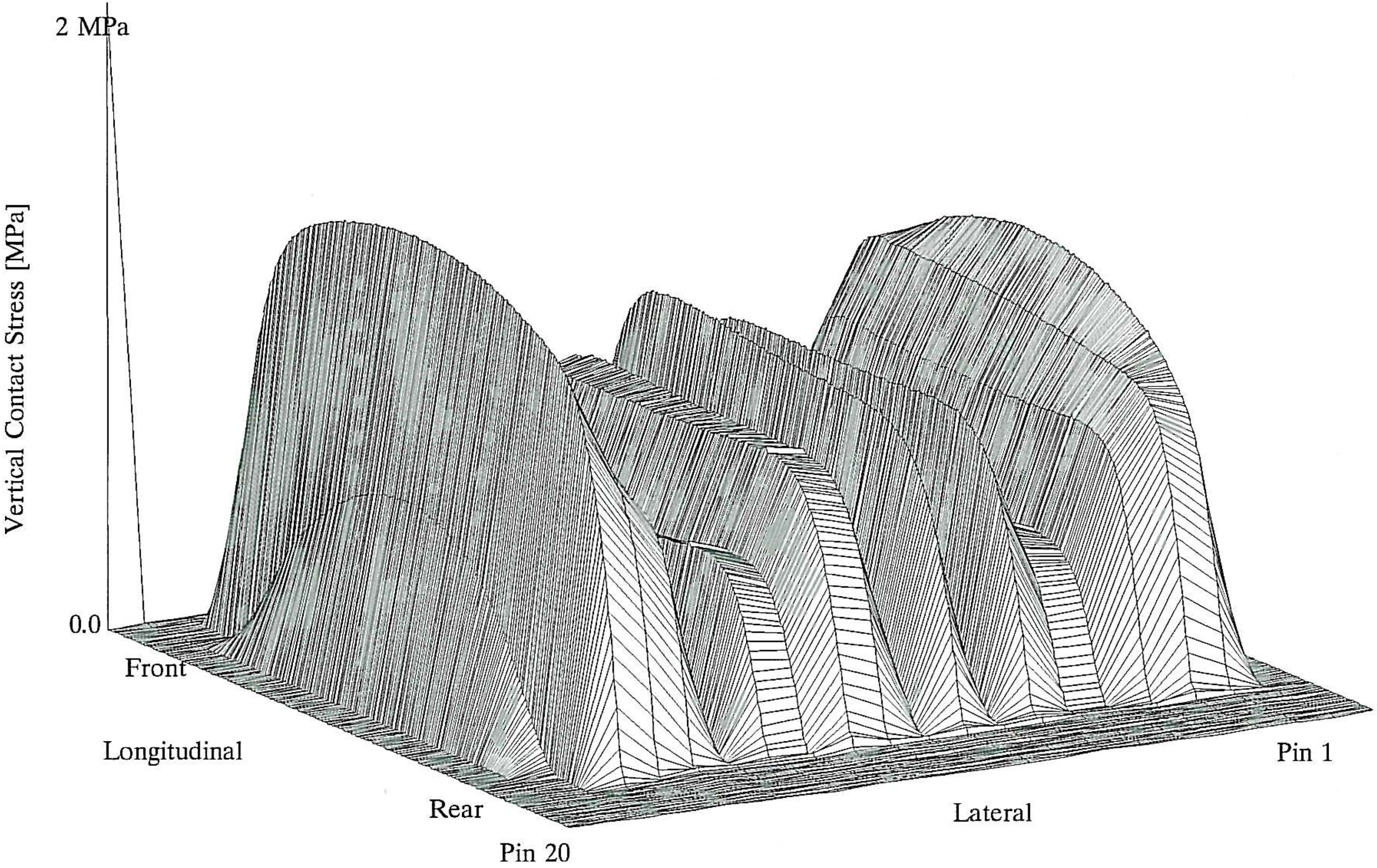
Used Bridgestone 425/65R22.5 R160AZ

Filename : nosc55cx

FIGURE A2X

Applied Vertical Load (HVS) = 75 kN
Measured Vertical Load = 78.61 kN
Max. Stress = 1.471 MPa

Inflation Press. = 500 kPa
Temperature = 18 deg.C
Wheel Speed = 0.308 m/s



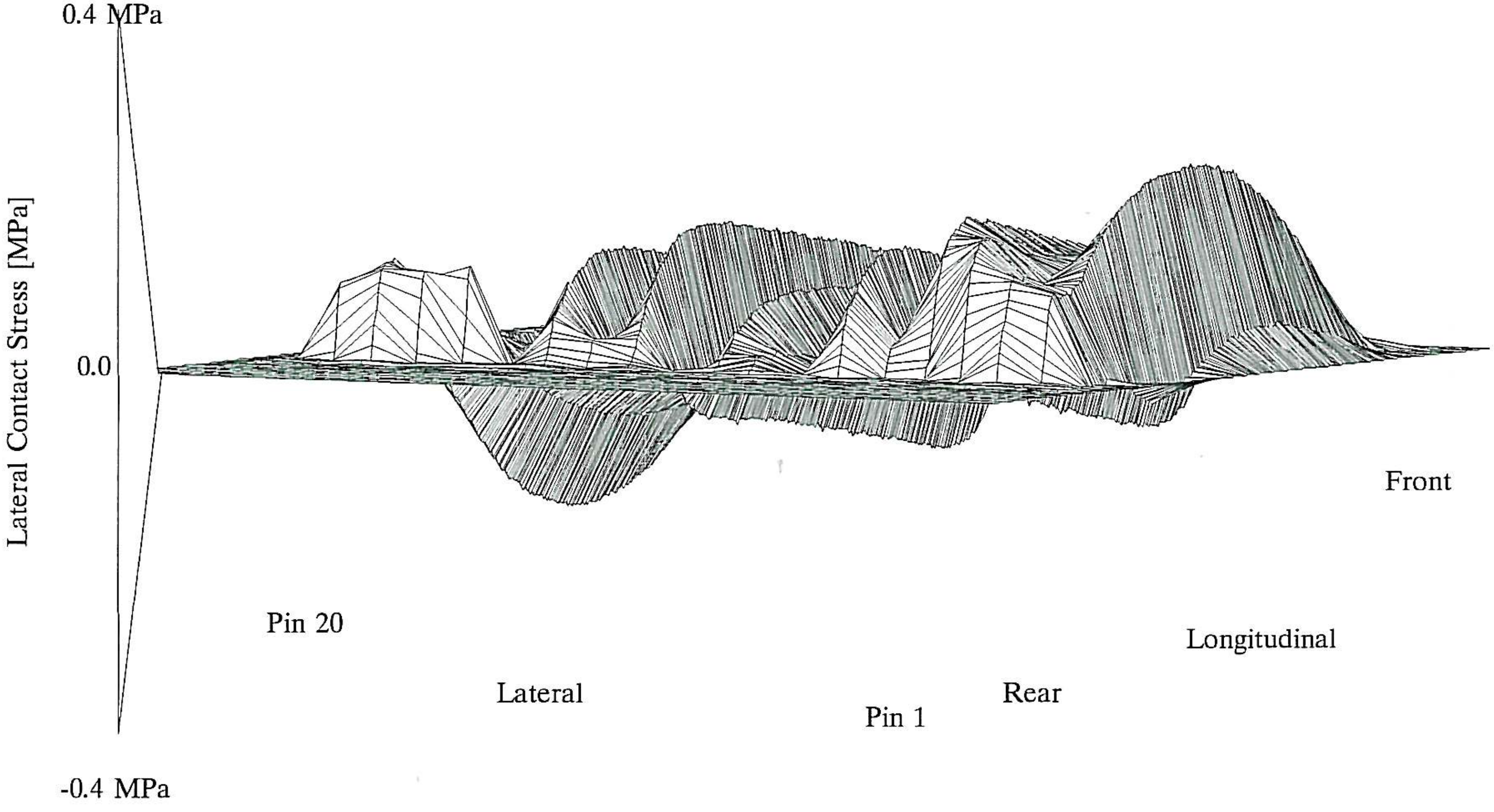
Used Bridgestone 425/65R22.5 R160AZ

FIGURE A3Z

Filename : nosc57az

Applied Vertical Load (HVS) = 75 kN
Measured Lateral Load = 3.275 kN
Max. Stress = 0.2269 MPa
Min. Stress = -0.1845 MPa

Inflation Press. = 500 kPa
Temperature = 18 deg.C
Wheel Speed = 0.308 m/s



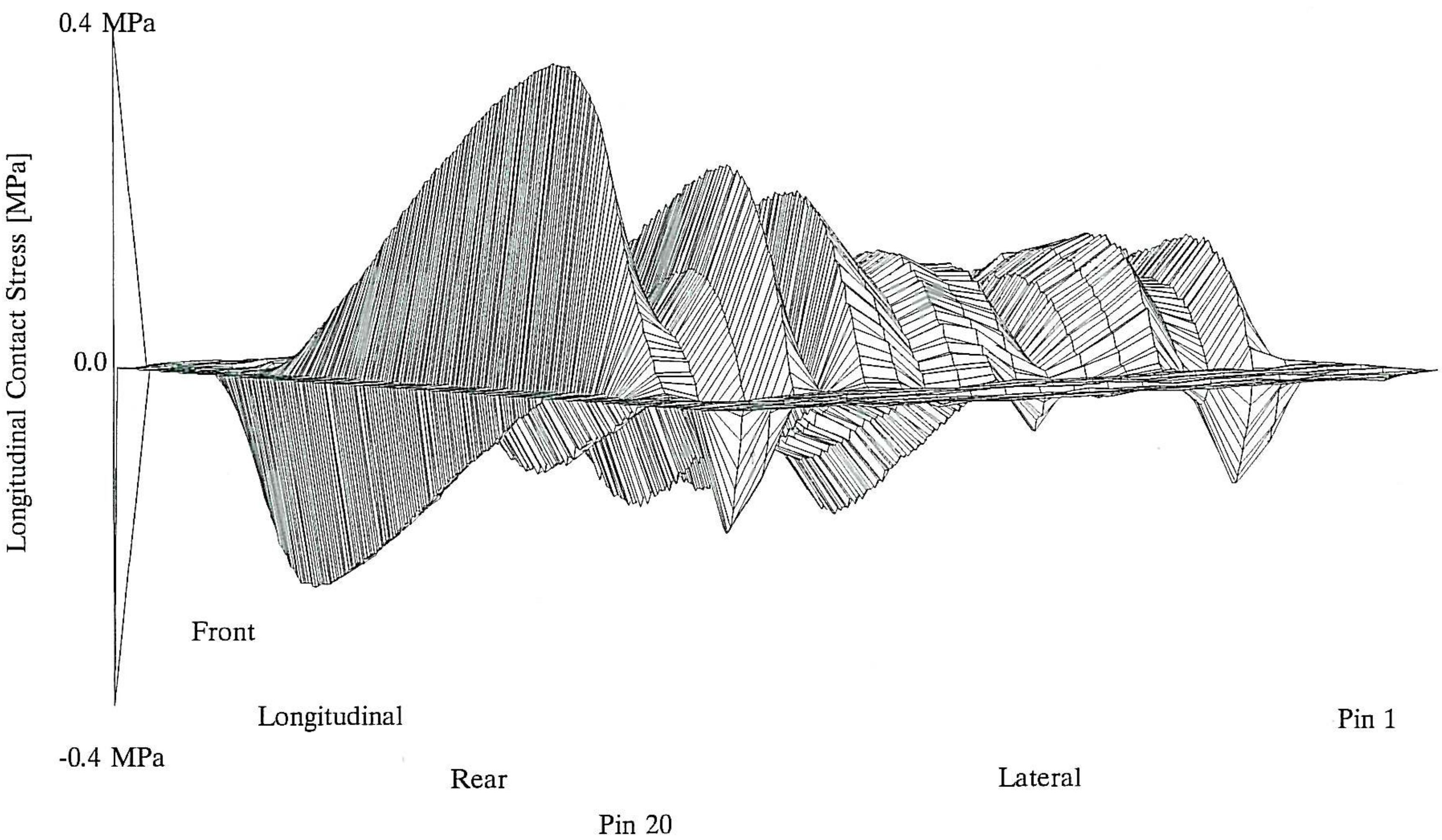
Used Bridgestone 425/65R22.5 R160AZ

FIGURE A3Y

Filename : nosc57ay

Applied Vertical Load (HVS) = 75 kN
Measured Longitudinal Load = 2.206 kN
Max. Stress = 0.386 MPa
Min. Stress = -0.2585 MPa

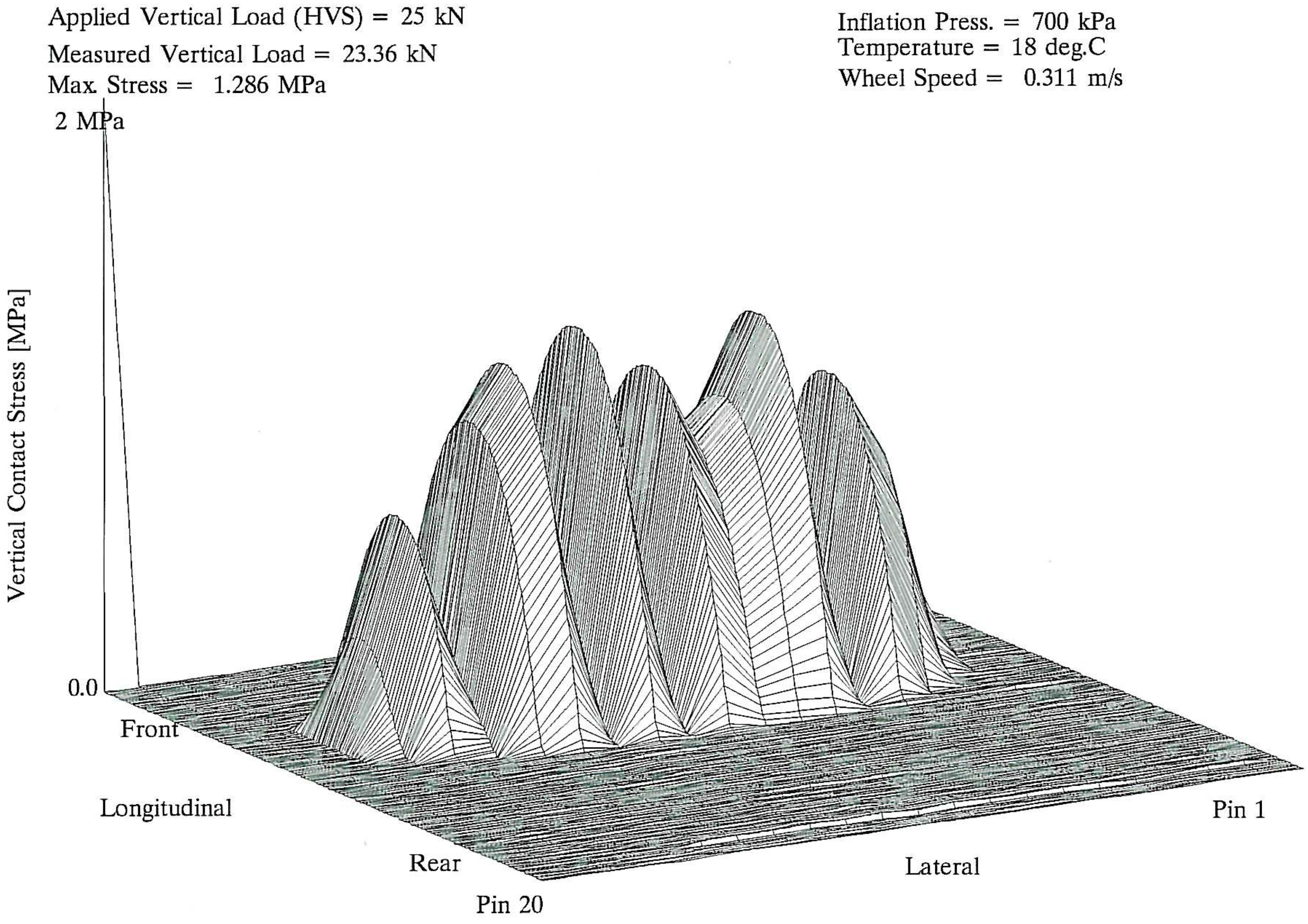
Inflation Press. = 500 kPa
Temperature = 18 deg.C
Wheel Speed = 0.308 m/s



Used Bridgestone 425/65R22.5 R160AZ

Filename : nosc57ax

FIGURE A3X



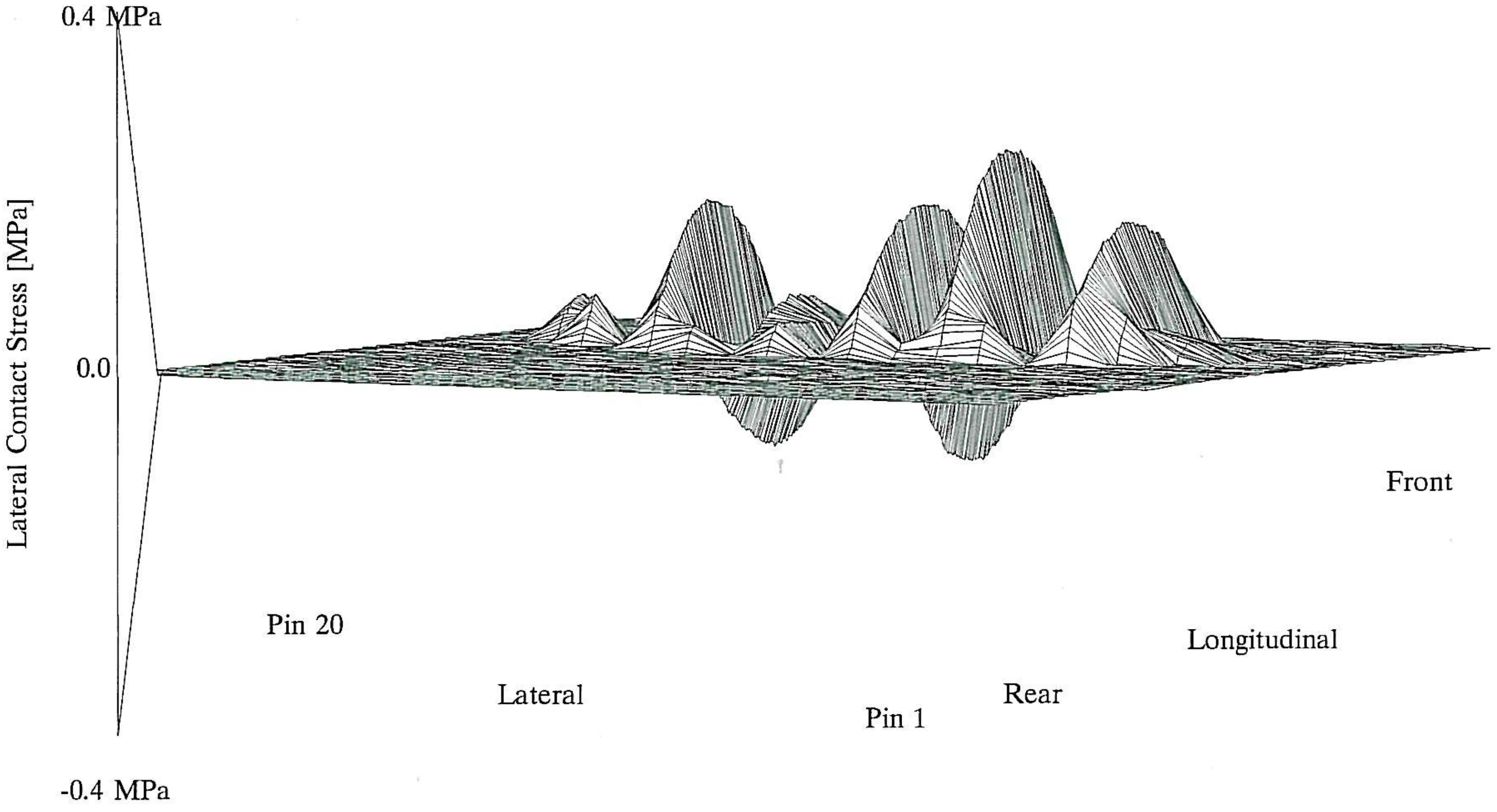
Used Bridgestone 425/65R22.5 R160AZ

Filename : nosc72bz

FIGURE A4Z

Applied Vertical Load (HVS) = 25 kN
Measured Lateral Load = 1.101 kN
Max. Stress = 0.2249 MPa
Min. Stress = -0.12 MPa

Inflation Press. = 700 kPa
Temperature = 18 deg.C
Wheel Speed = 0.311 m/s



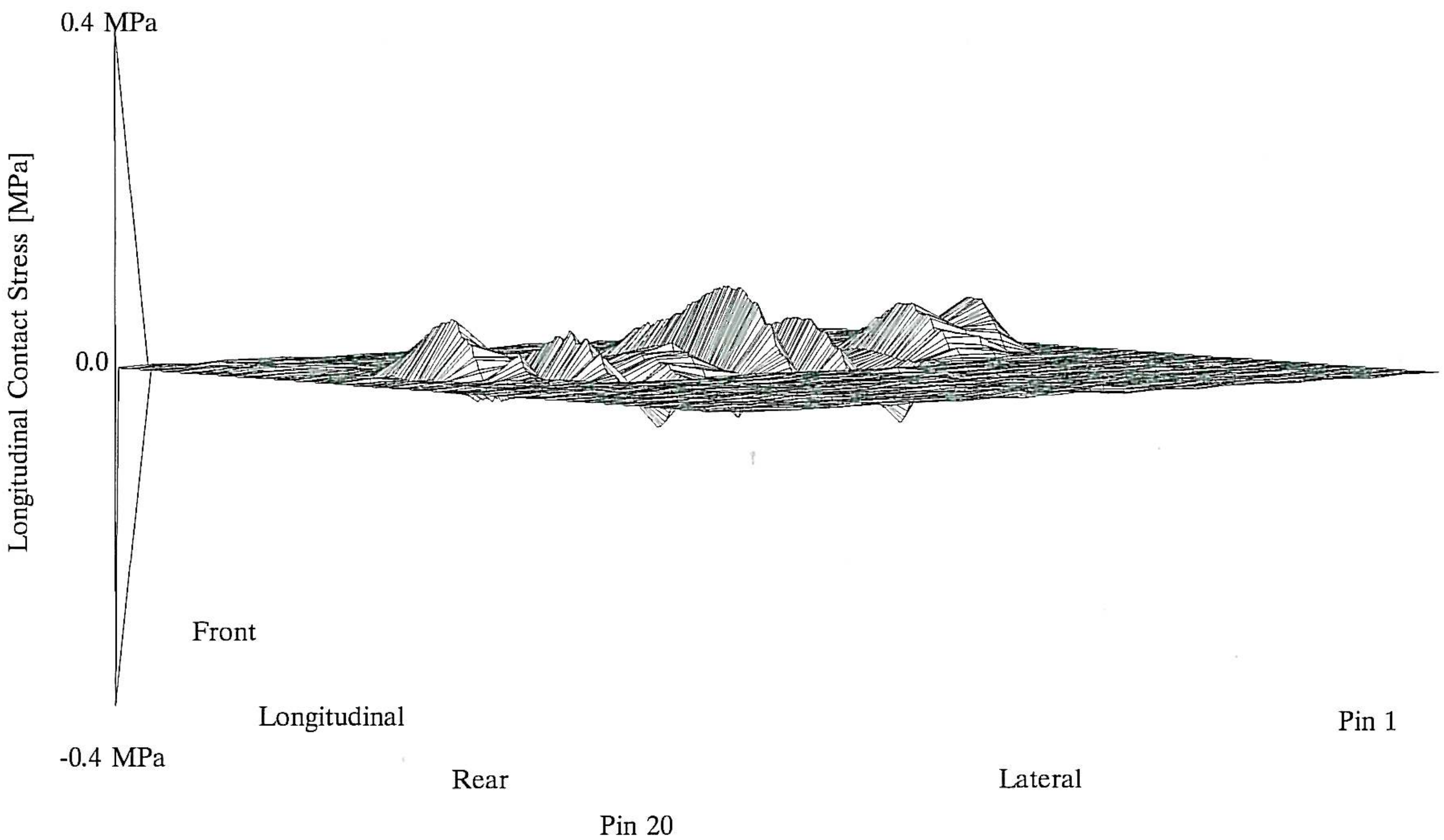
Used Bridgestone 425/65R22.5 R160AZ

Filename : nosc72by

FIGURE A4Y

Applied Vertical Load (HVS) = 25 kN
Measured Longitudinal Load = 0.1443 kN
Max. Stress = 0.09425 MPa
Min. Stress = -0.06884 MPa

Inflation Press. = 700 kPa
Temperature = 18 deg.C
Wheel Speed = 0.311 m/s



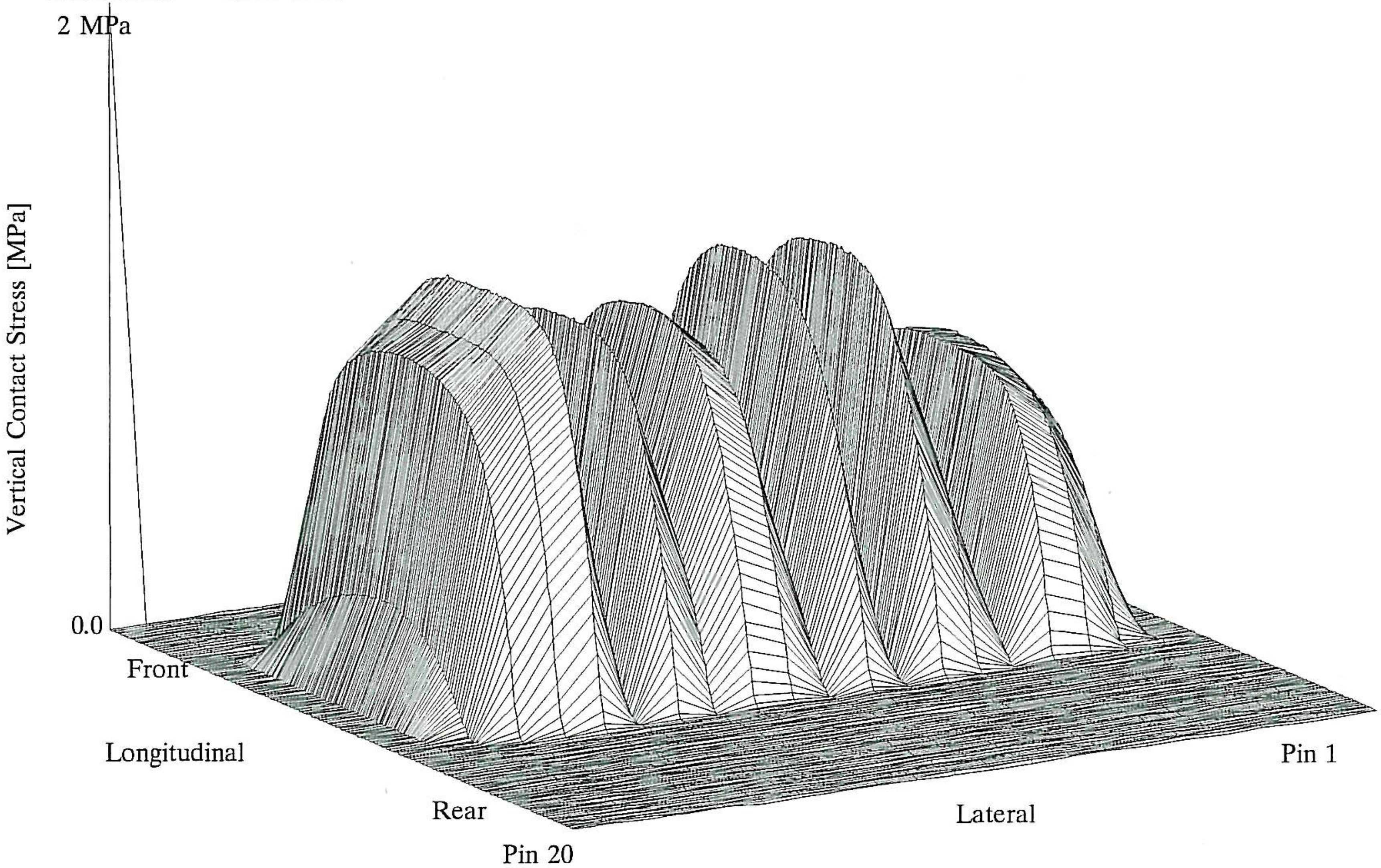
Used Bridgestone 425/65R22.5 R160AZ

FIGURE A4X

Filename : nosc72bx

Applied Vertical Load (HVS) = 50 kN
Measured Vertical Load = 48.63 kN
Max. Stress = 1.255 MPa

Inflation Press. = 700 kPa
Temperature = 19 deg.C
Wheel Speed = 0.311 m/s



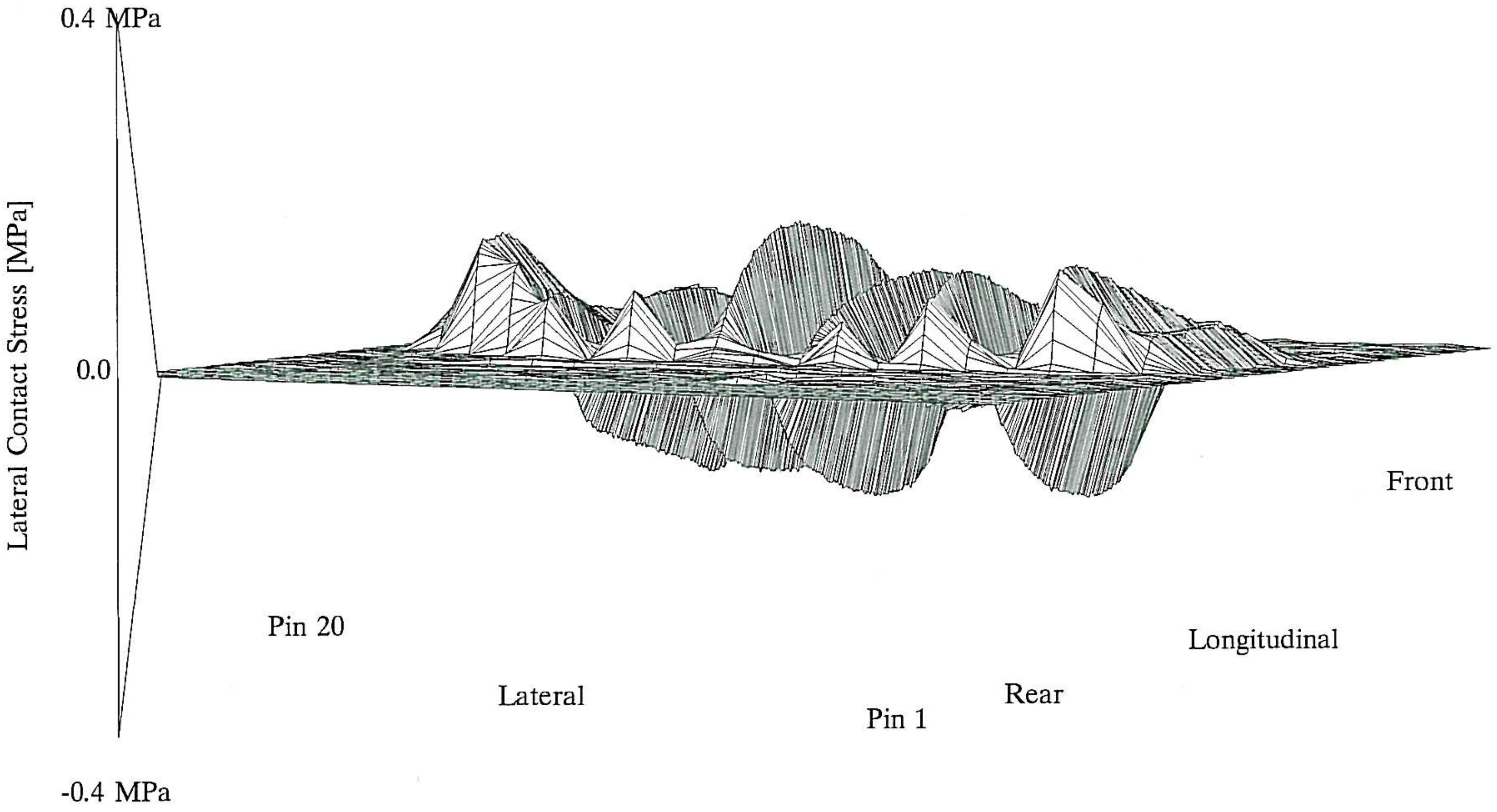
Used Bridgestone 425/65R22.5 R160AZ

Filename : nosc75az

FIGURE A5Z

Applied Vertical Load (HVS) = 50 kN
Measured Lateral Load = 0.5117 kN
Max. Stress = 0.1478 MPa
Min. Stress = -0.1614 MPa

Inflation Press. = 700 kPa
Temperature = 19 deg.C
Wheel Speed = 0.311 m/s



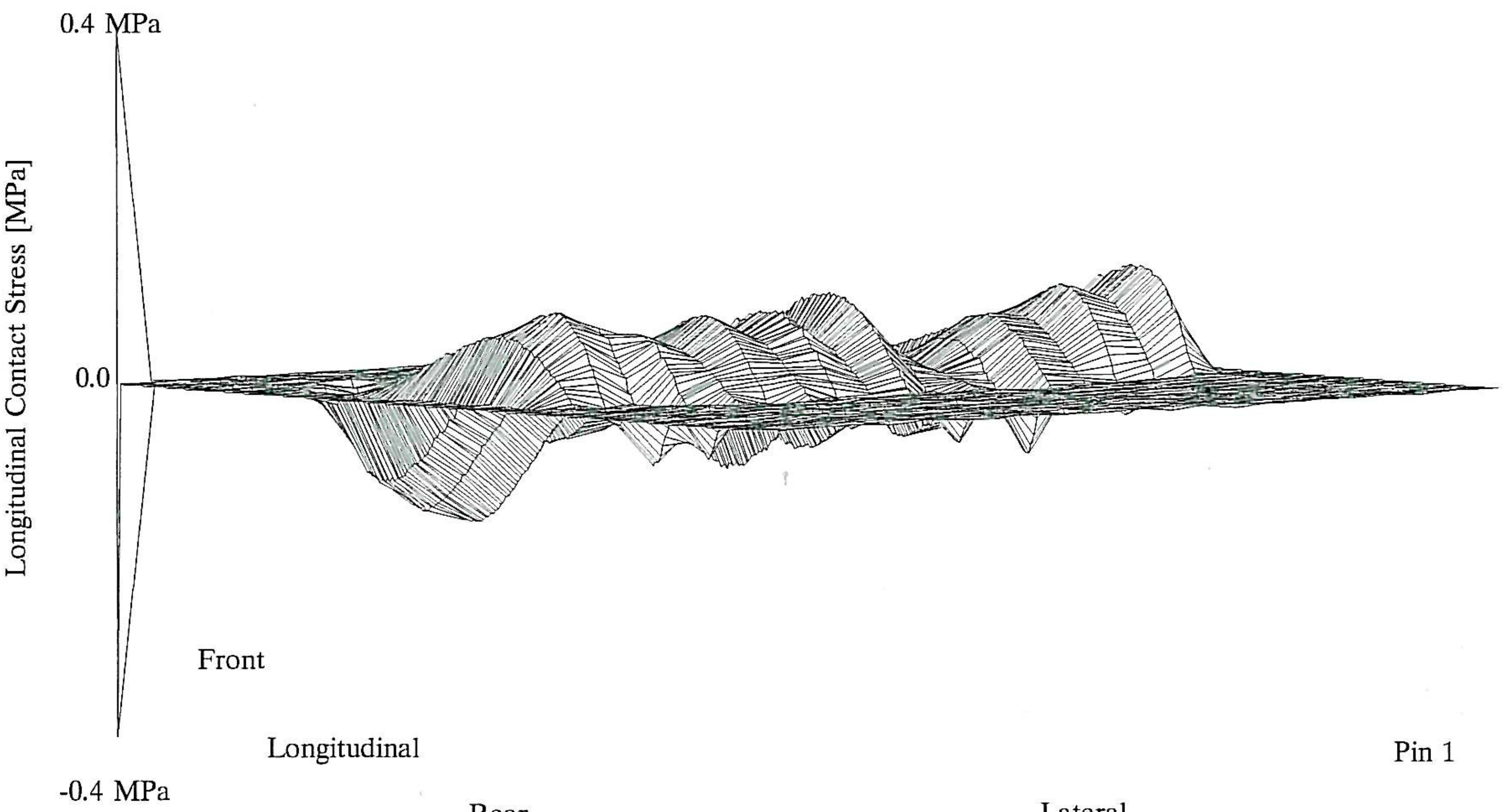
Used Bridgestone 425/65R22.5 R160AZ

Filename : nosc75ay

FIGURE A5Y

Applied Vertical Load (HVS) = 50 kN
Measured Longitudinal Load = 0.3197 kN
Max. Stress = 0.1211 MPa
Min. Stress = -0.1532 MPa

Inflation Press. = 700 kPa
Temperature = 19 deg.C
Wheel Speed = 0.311 m/s



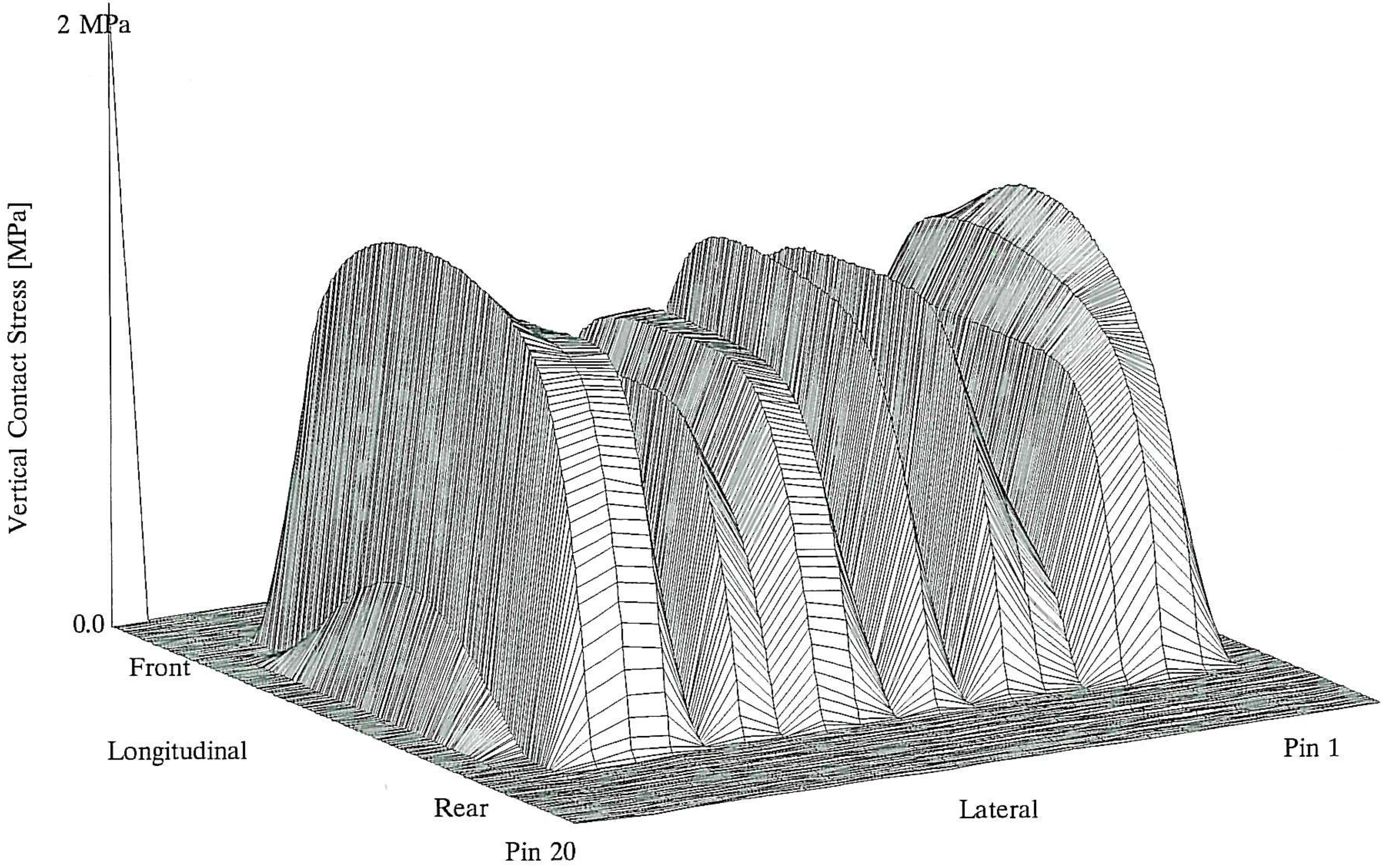
Used Bridgestone 425/65R22.5 R160AZ

Filename : nosc75ax

FIGURE A5X

Applied Vertical Load (HVS) = 75 kN
Measured Vertical Load = 73.65 kN
Max. Stress = 1.427 MPa

Inflation Press. = 700 kPa
Temperature = 19 deg.C
Wheel Speed = 0.306 m/s



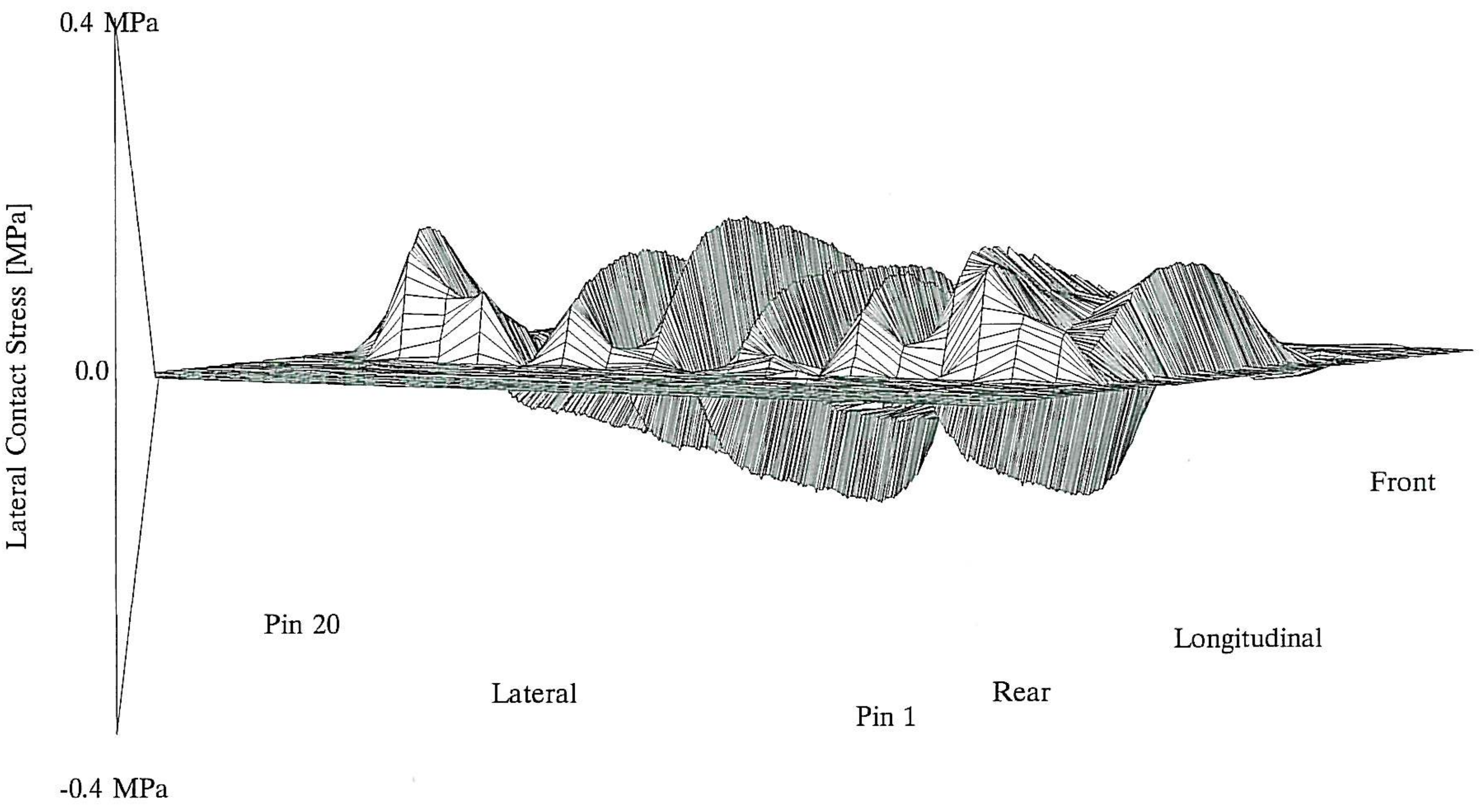
Used Bridgestone 425/65R22.5 R160AZ

FIGURE A6Z

Filename : nosc77az

Applied Vertical Load (HVS) = 75 kN
Measured Lateral Load = 0.9063 kN
Max. Stress = 0.1608 MPa
Min. Stress = -0.1702 MPa

Inflation Press. = 700 kPa
Temperature = 19 deg.C
Wheel Speed = 0.306 m/s



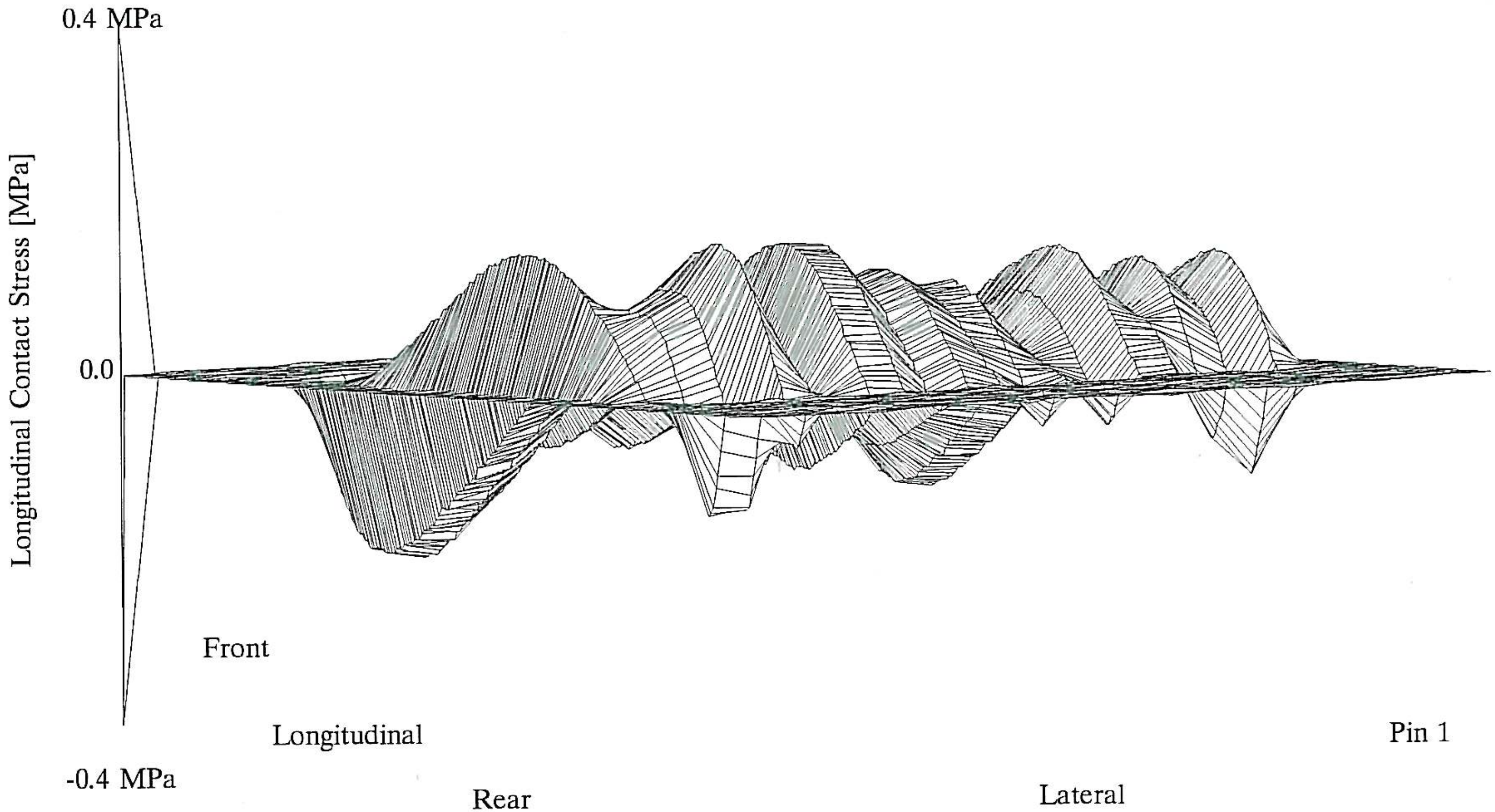
Used Bridgestone 425/65R22.5 R160AZ

FIGURE A6Y

Filename : nosc77ay

Applied Vertical Load (HVS) = 75 kN
Measured Longitudinal Load = 0.6806 kN
Max. Stress = 0.1707 MPa
Min. Stress = -0.2059 MPa

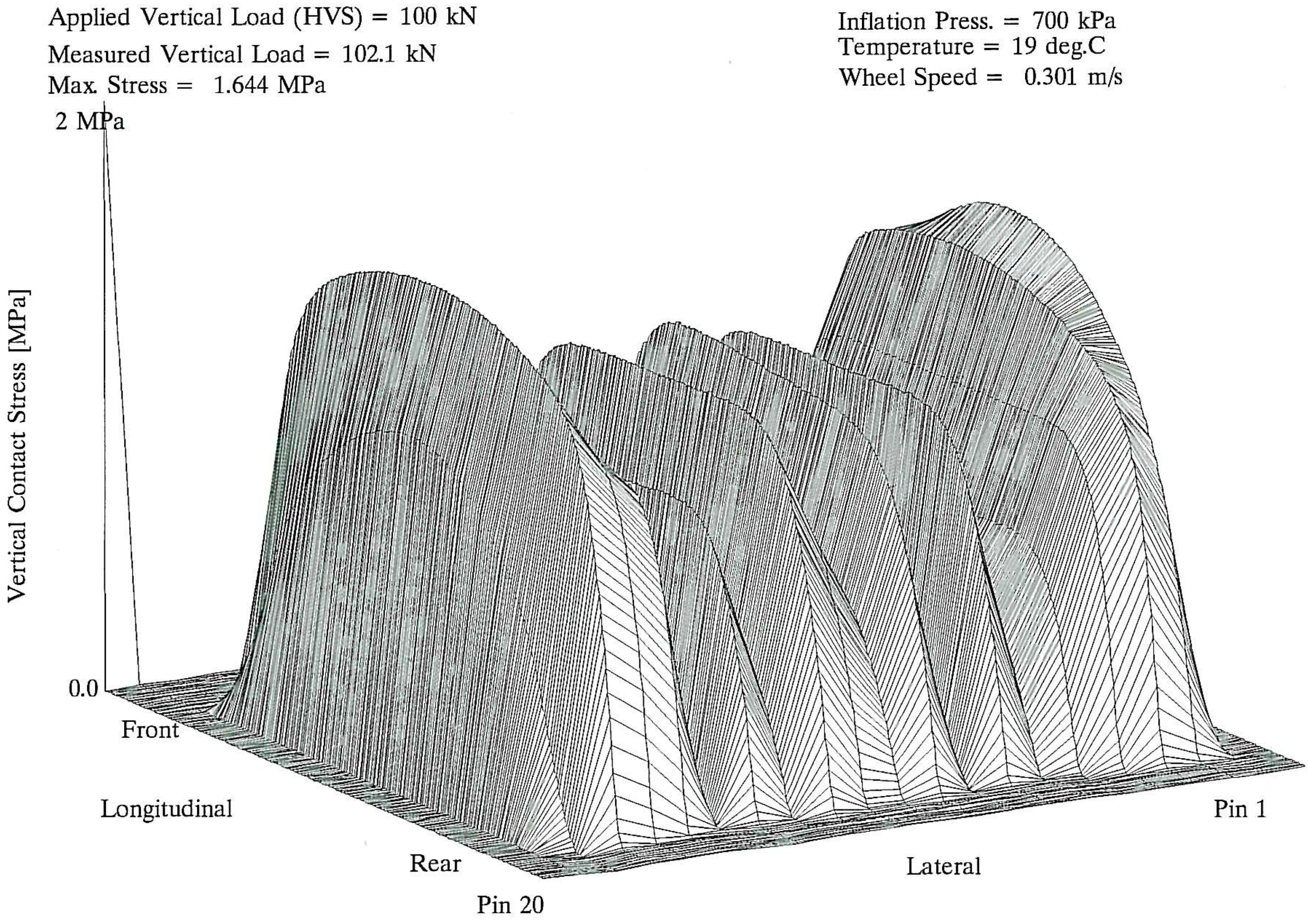
Inflation Press. = 700 kPa
Temperature = 19 deg.C
Wheel Speed = 0.306 m/s



Used Bridgestone 425/65R22.5 R160AZ

Filename : nosc77ax

FIGURE A6X



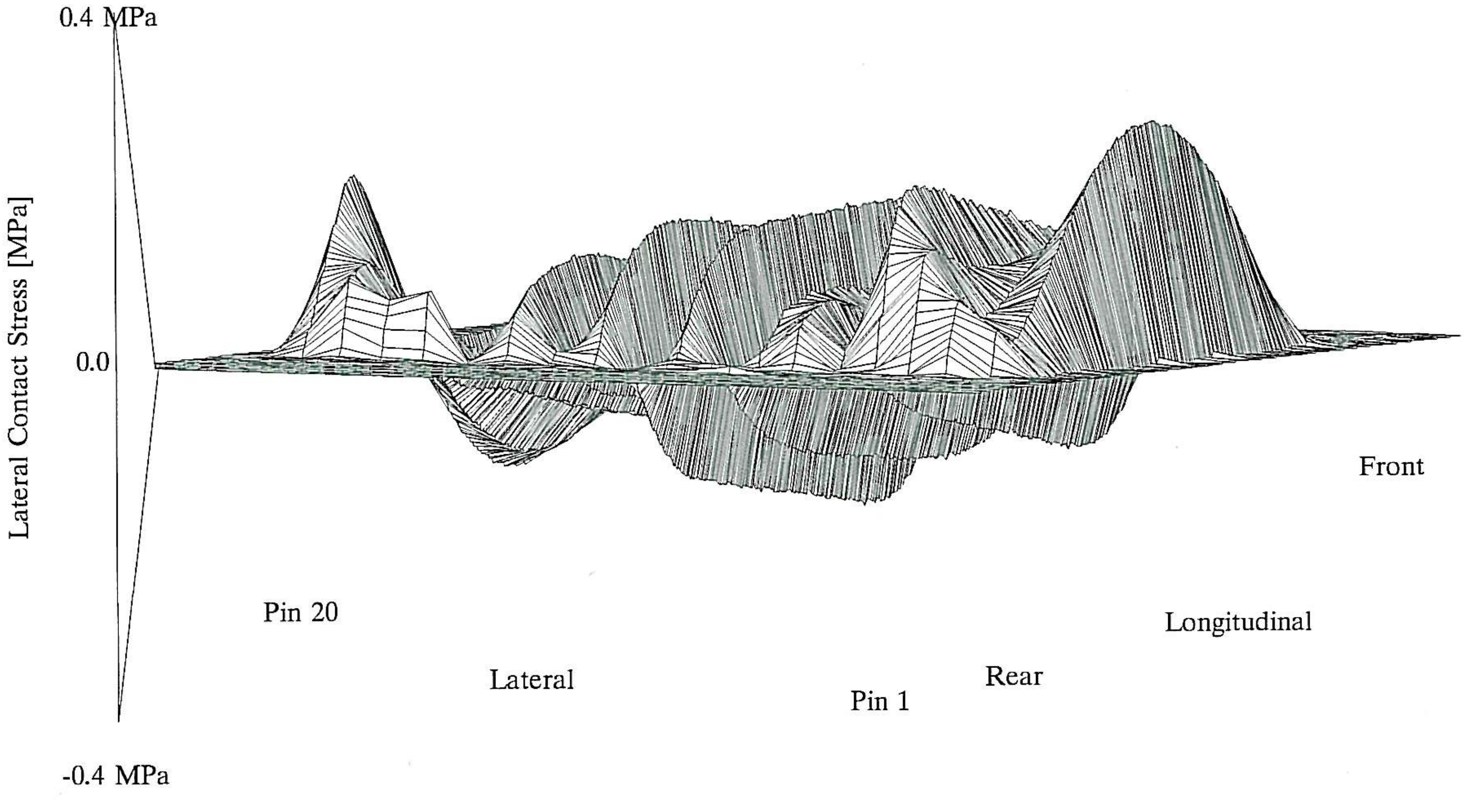
Used Bridgestone 425/65R22.5 R160AZ

Filename : nosc71az

FIGURE A7Z

Applied Vertical Load (HVS) = 100 kN
Measured Lateral Load = 2.28 kN
Max. Stress = 0.2693 MPa
Min. Stress = -0.1872 MPa

Inflation Press. = 700 kPa
Temperature = 19 deg.C
Wheel Speed = 0.301 m/s



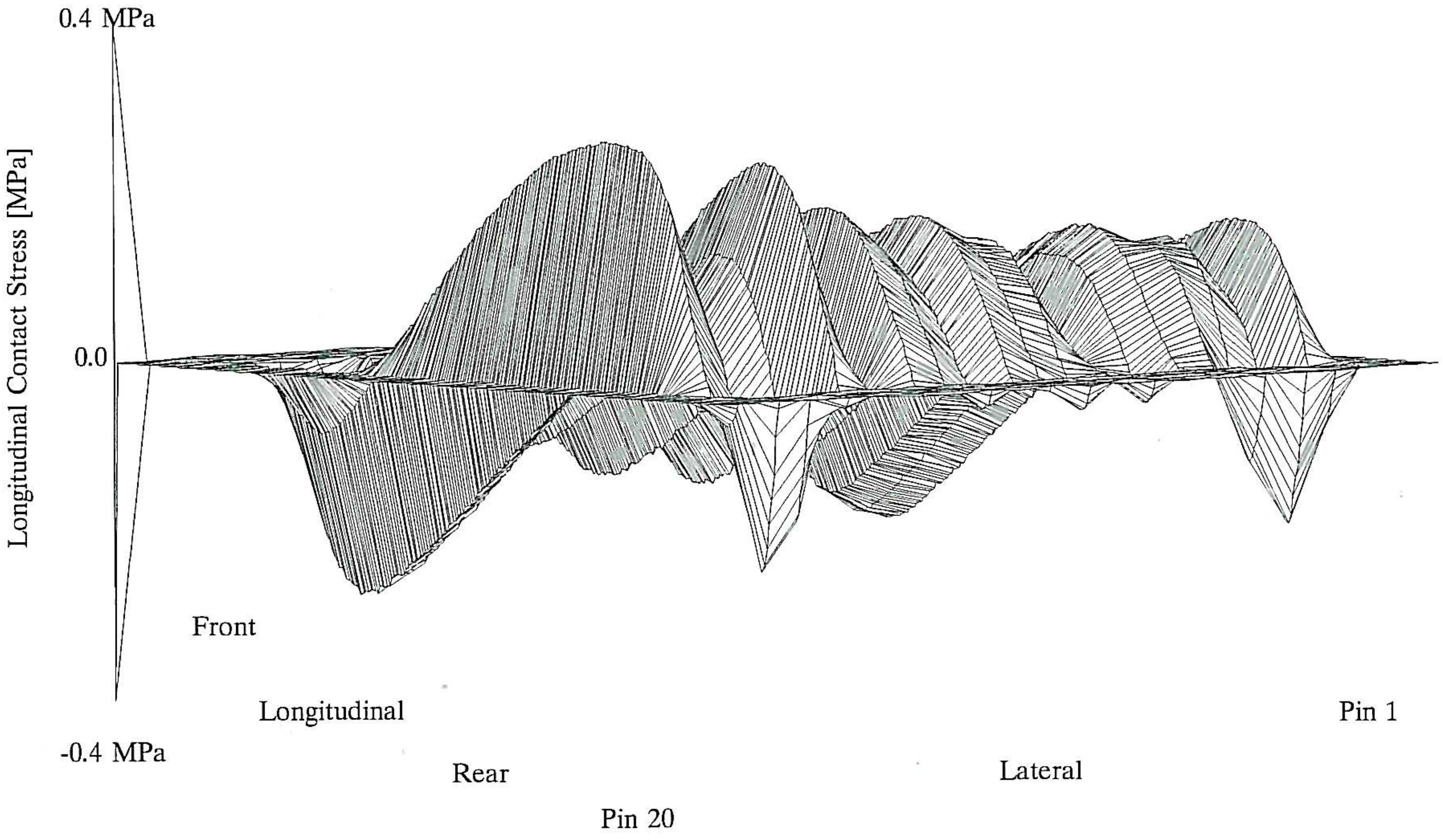
Used Bridgestone 425/65R22.5 R160AZ

FIGURE A7Y

Filename : nosc71ay

Applied Vertical Load (HVS) = 100 kN
Measured Longitudinal Load = 1.743 kN
Max. Stress = 0.2919 MPa
Min. Stress = -0.2707 MPa

Inflation Press. = 700 kPa
Temperature = 19 deg.C
Wheel Speed = 0.301 m/s



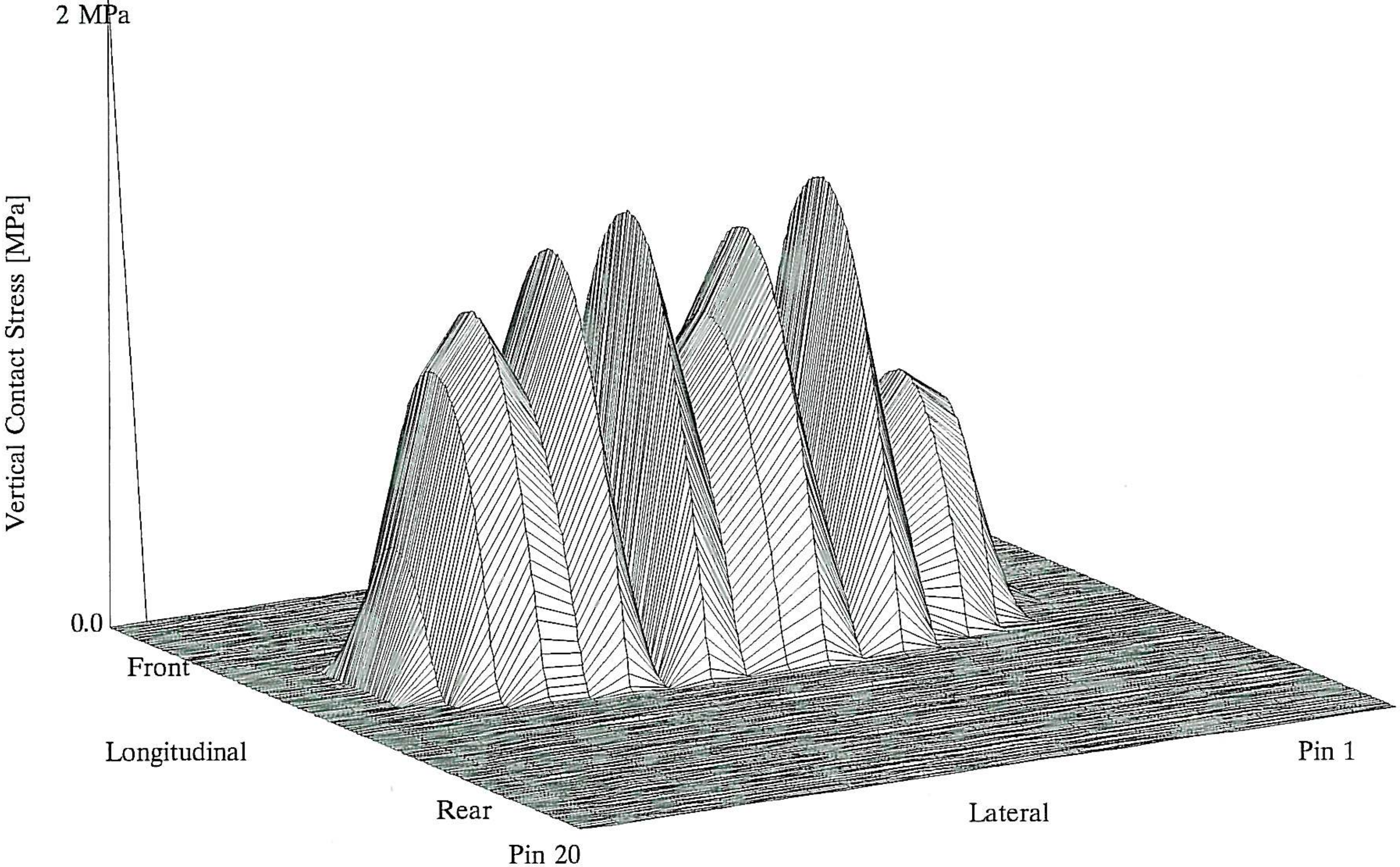
Used Bridgestone 425/65R22.5 R160AZ

Filename : nosc71ax

FIGURE A7X

Applied Vertical Load (HVS) = 25 kN
Measured Vertical Load = 24.06 kN
Max. Stress = 1.397 MPa

Inflation Press. = 900 kPa
Temperature = 25 deg.C
Wheel Speed = 0.296 m/s



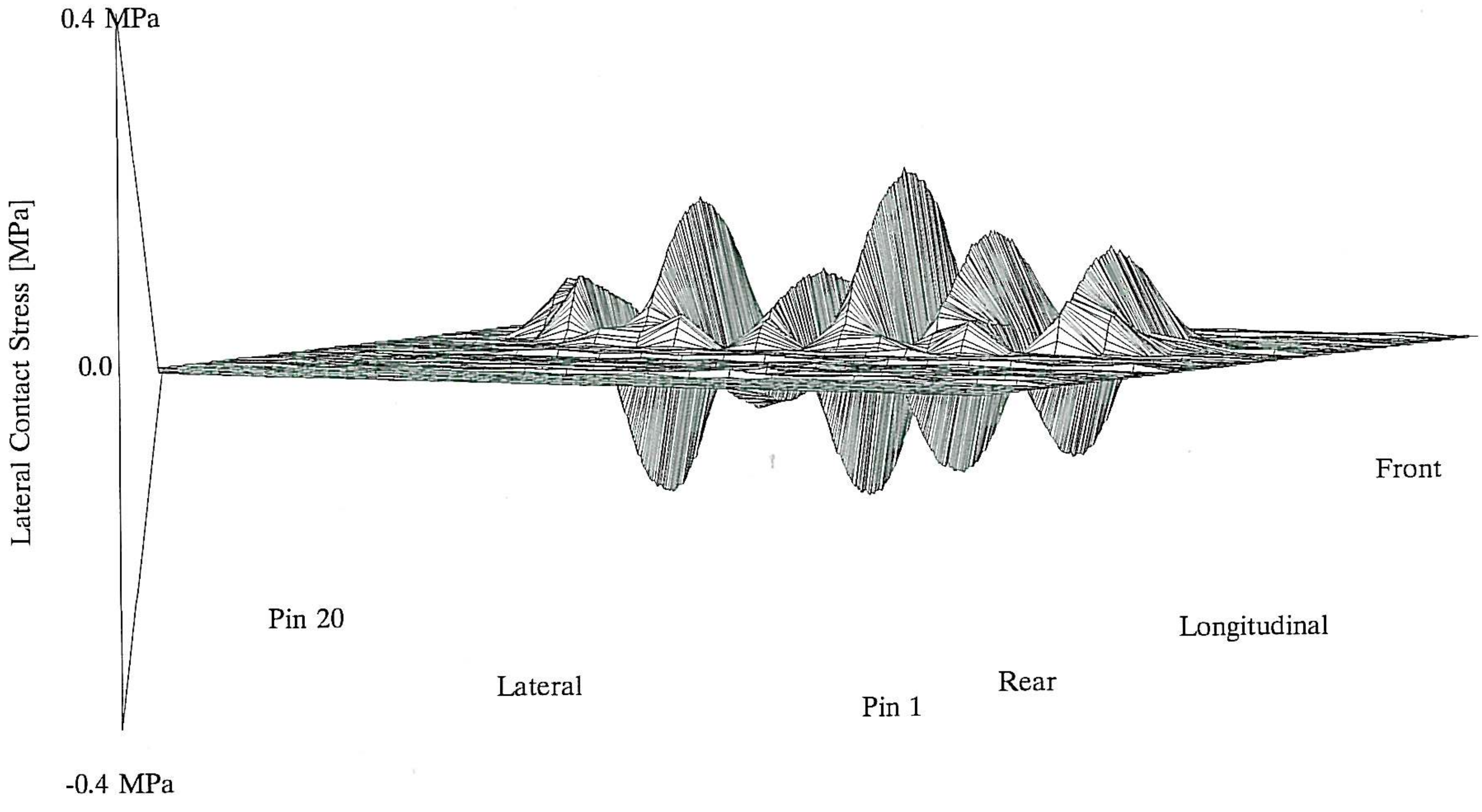
Used Bridgestone 425/65R22.5 R160AZ

Filename : noc902cz

FIGURE A8Z

Applied Vertical Load (HVS) = 25 kN
Measured Lateral Load = 0.2513 kN
Max. Stress = 0.1988 MPa
Min. Stress = -0.174 MPa

Inflation Press. = 900 kPa
Temperature = 25 deg.C
Wheel Speed = 0.296 m/s



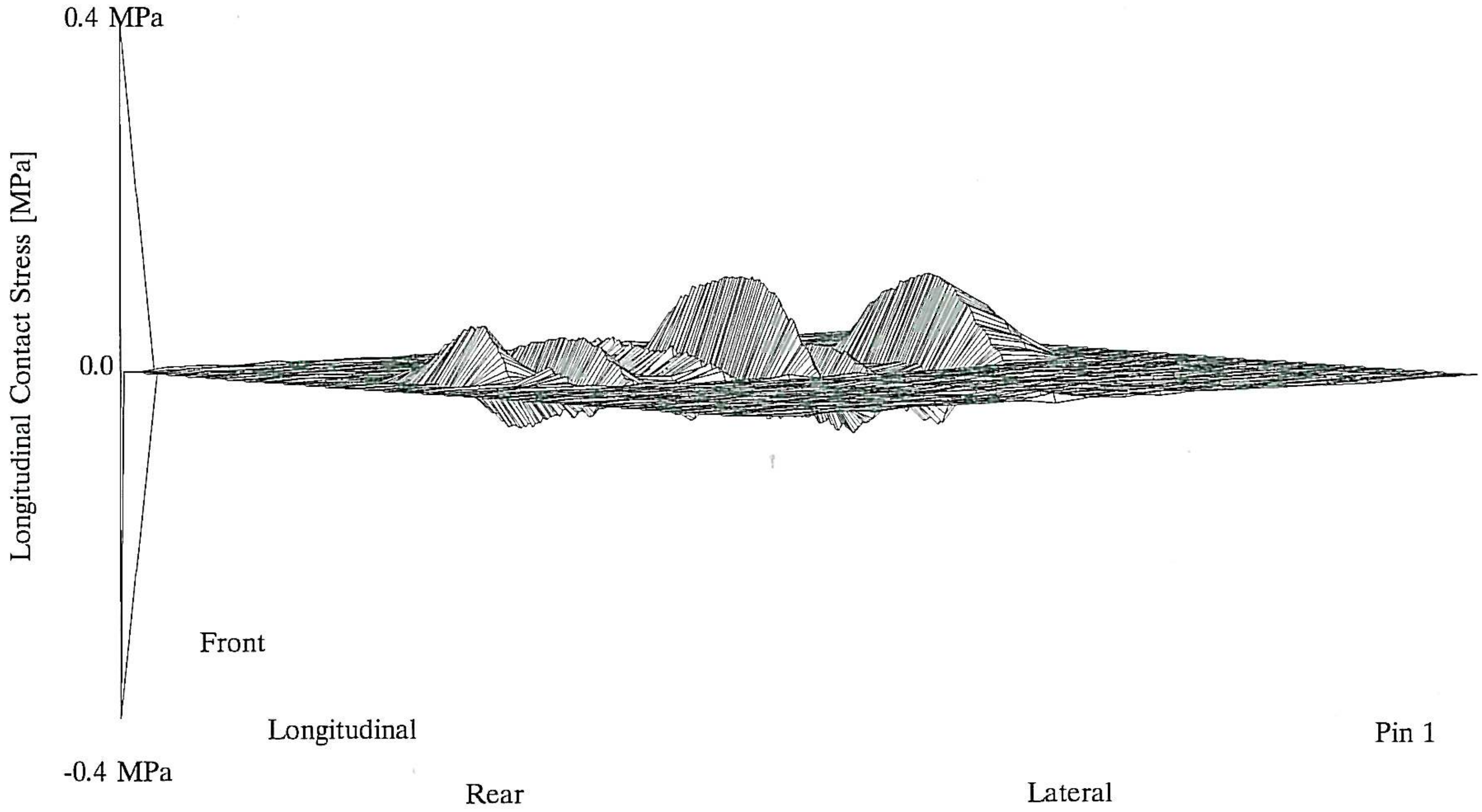
Used Bridgestone 425/65R22.5 R160AZ

FIGURE A8Y

Filename : noc902cy

Applied Vertical Load (HVS) = 25 kN
Measured Longitudinal Load = 0.2638 kN
Max. Stress = 0.1052 MPa
Min. Stress = -0.0716 MPa

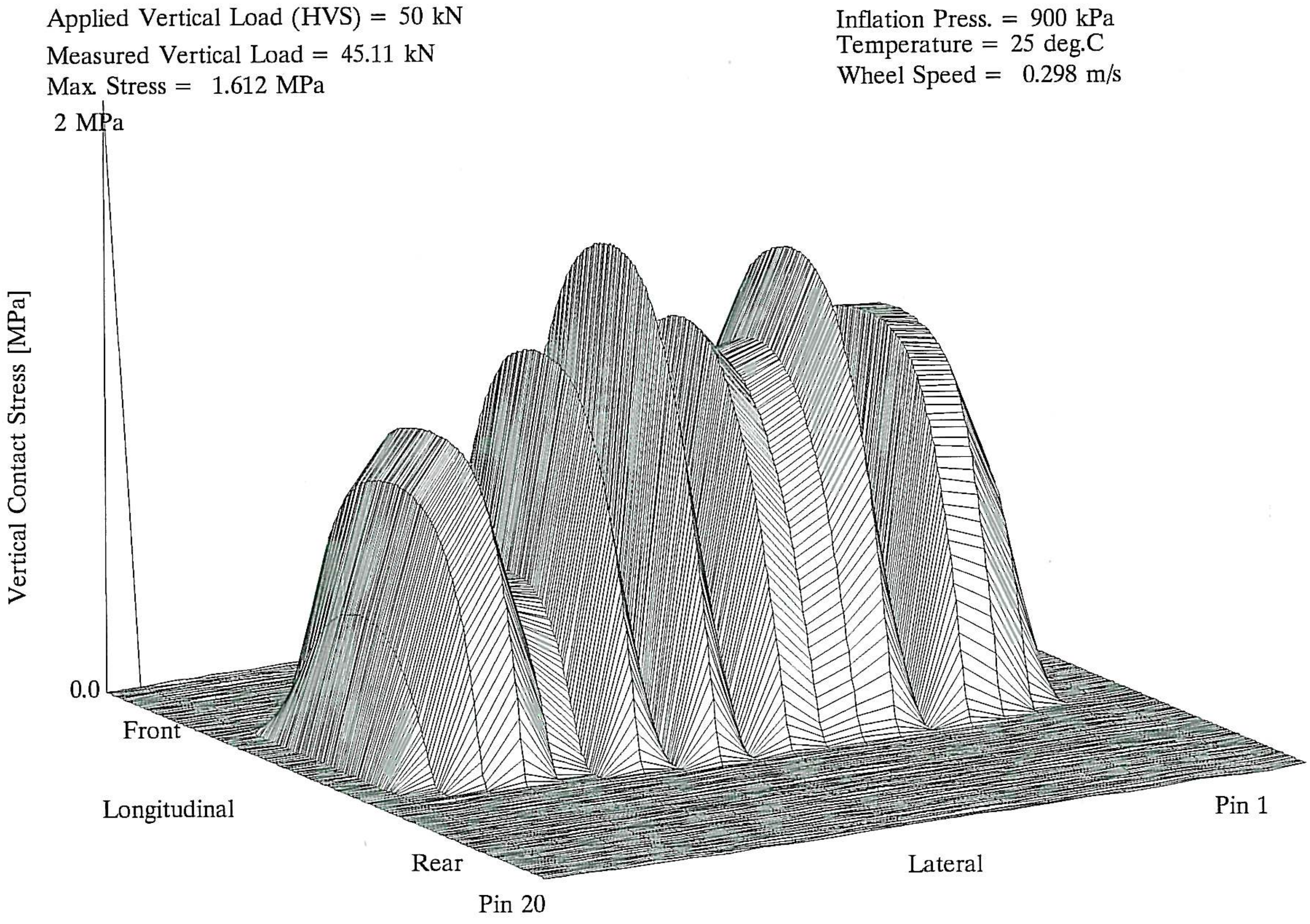
Inflation Press. = 900 kPa
Temperature = 25 deg.C
Wheel Speed = 0.296 m/s



Used Bridgestone 425/65R22.5 R160AZ

Filename : noc902cx

FIGURE A8X



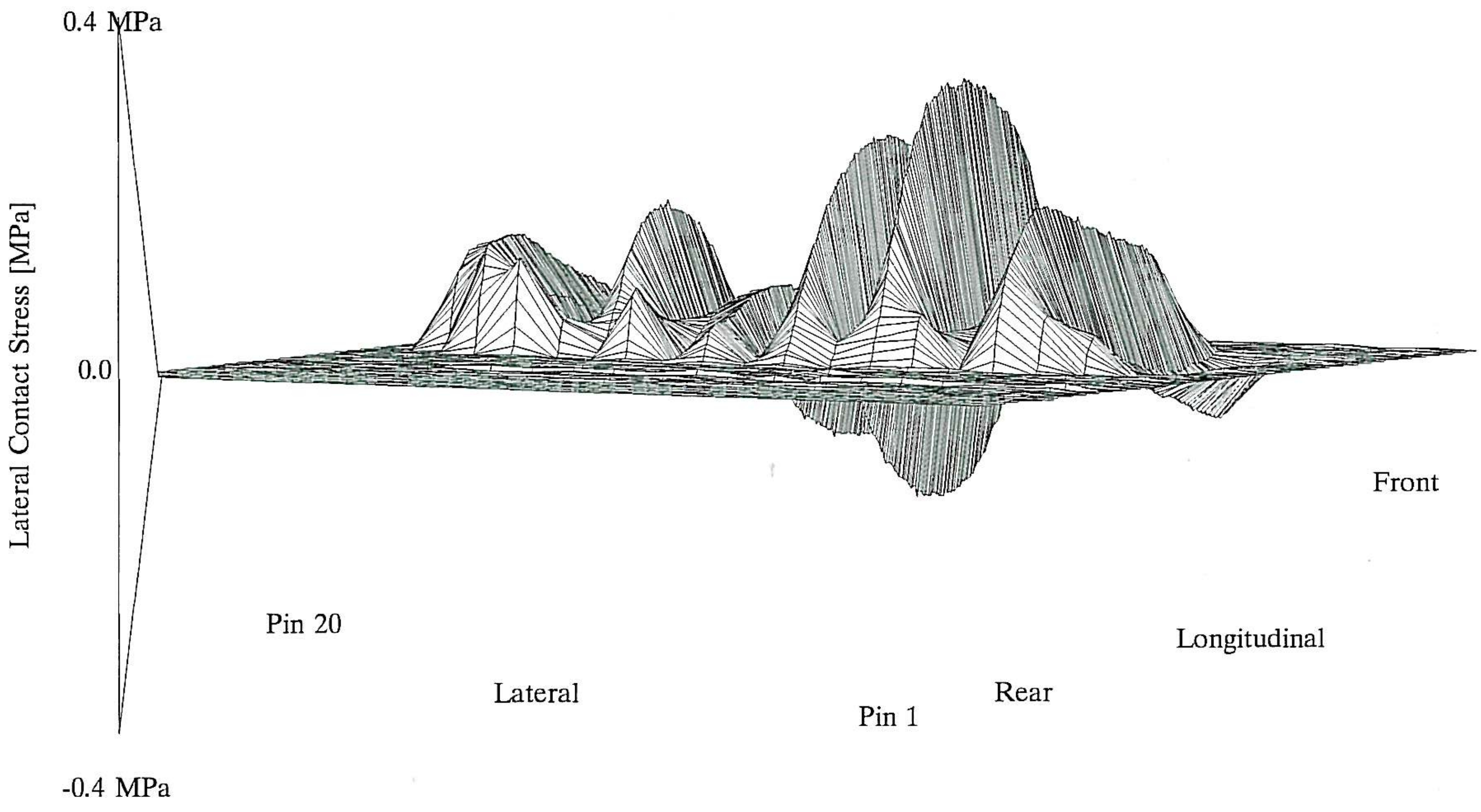
Used Bridgestone 425/65R22.5 R160AZ

Filename : noc905az

FIGURE A9Z

Applied Vertical Load (HVS) = 50 kN
Measured Lateral Load = 2.805 kN
Max. Stress = 0.3137 MPa
Min. Stress = -0.1557 MPa

Inflation Press. = 900 kPa
Temperature = 25 deg.C
Wheel Speed = 0.298 m/s



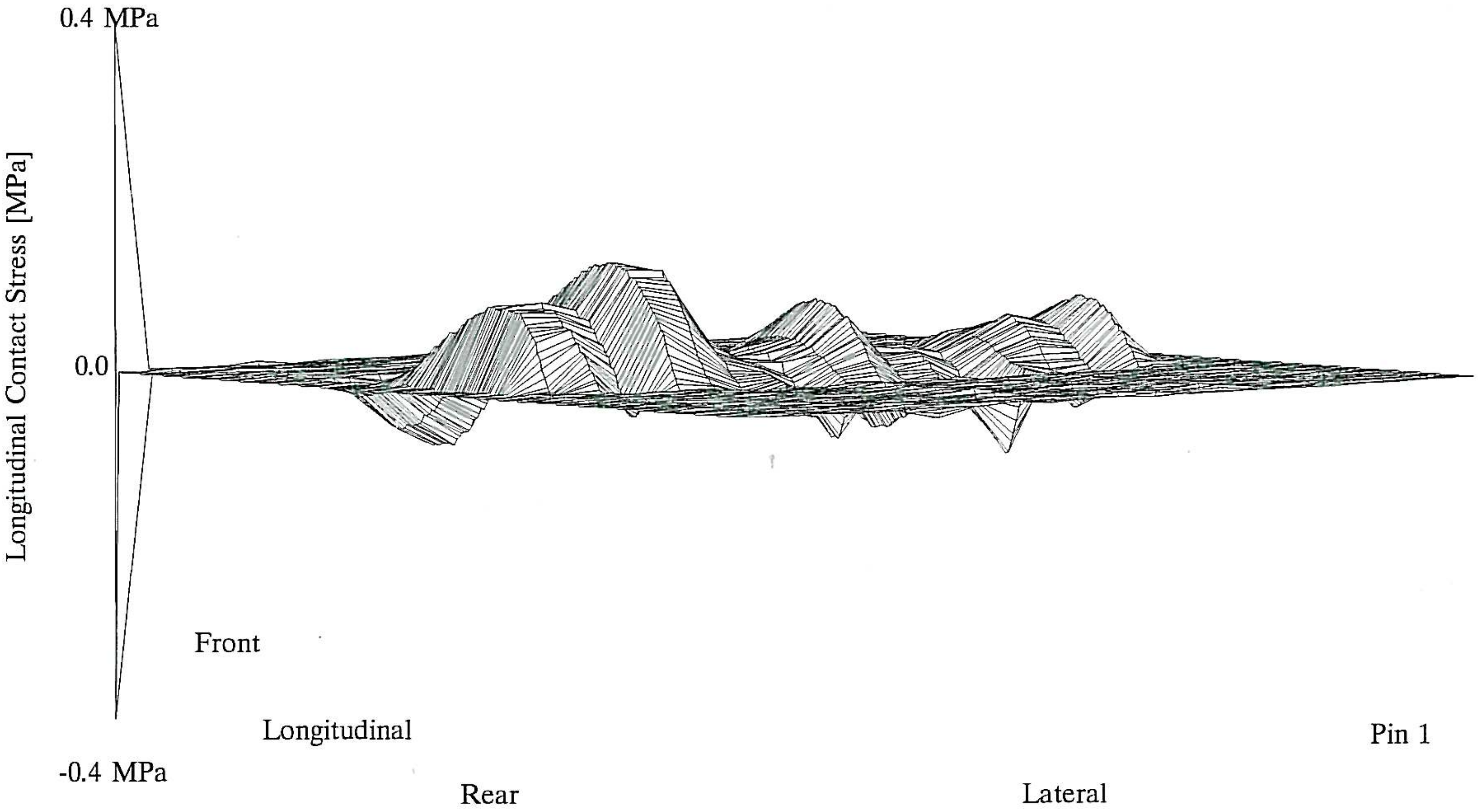
Used Bridgestone 425/65R22.5 R160AZ

FIGURE A9Y

Filename : noc905ay

Applied Vertical Load (HVS) = 50 kN
Measured Longitudinal Load = 0.5735 kN
Max. Stress = 0.142 MPa
Min. Stress = -0.0903 MPa

Inflation Press. = 900 kPa
Temperature = 25 deg.C
Wheel Speed = 0.298 m/s



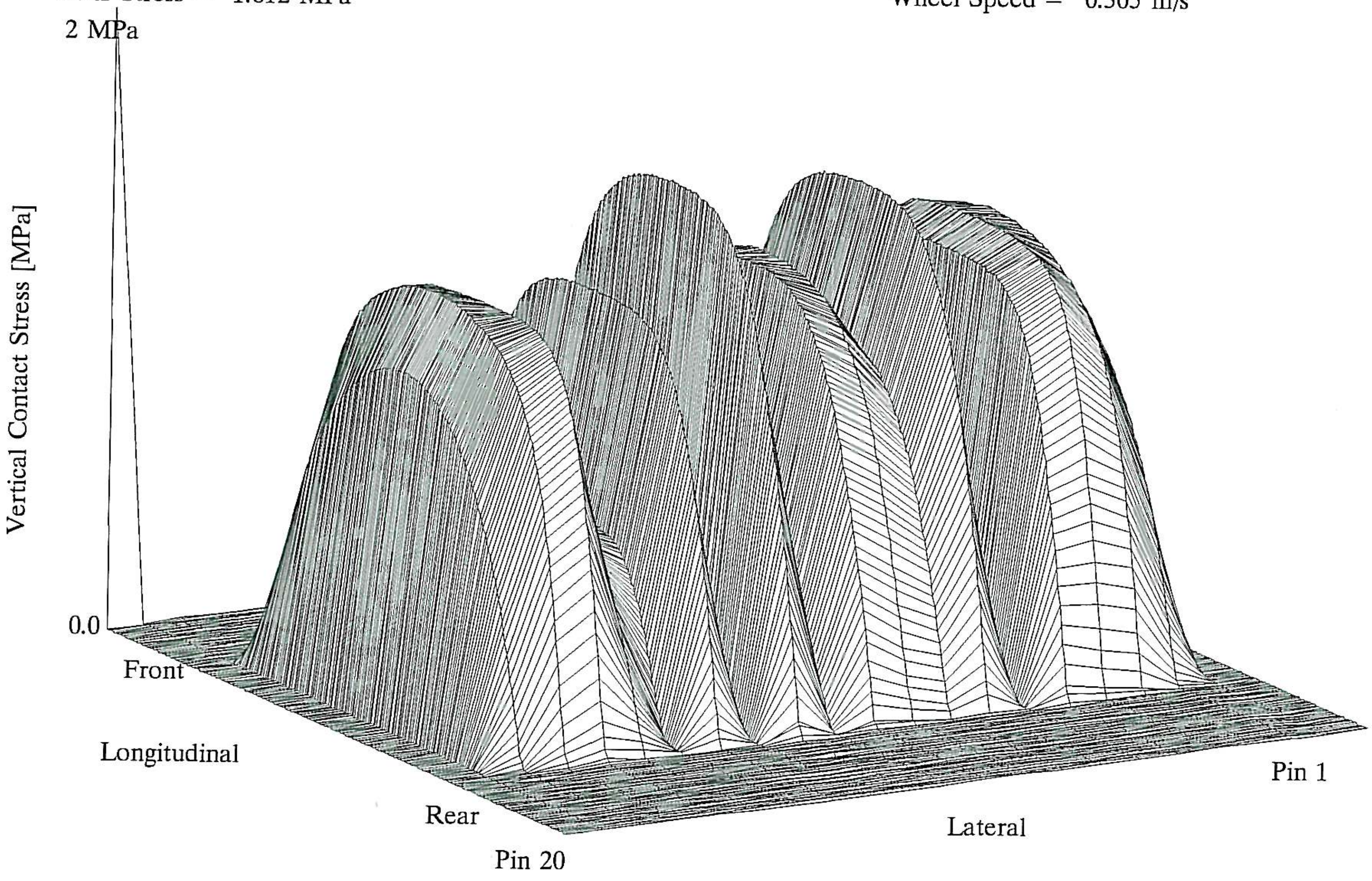
Used Bridgestone 425/65R22.5 R160AZ

Filename : noc905ax

FIGURE A9X

Applied Vertical Load (HVS) = 75 kN
Measured Vertical Load = 77.6 kN
Max. Stress = 1.612 MPa

Inflation Press. = 900 kPa
Temperature = 25 deg.C
Wheel Speed = 0.305 m/s



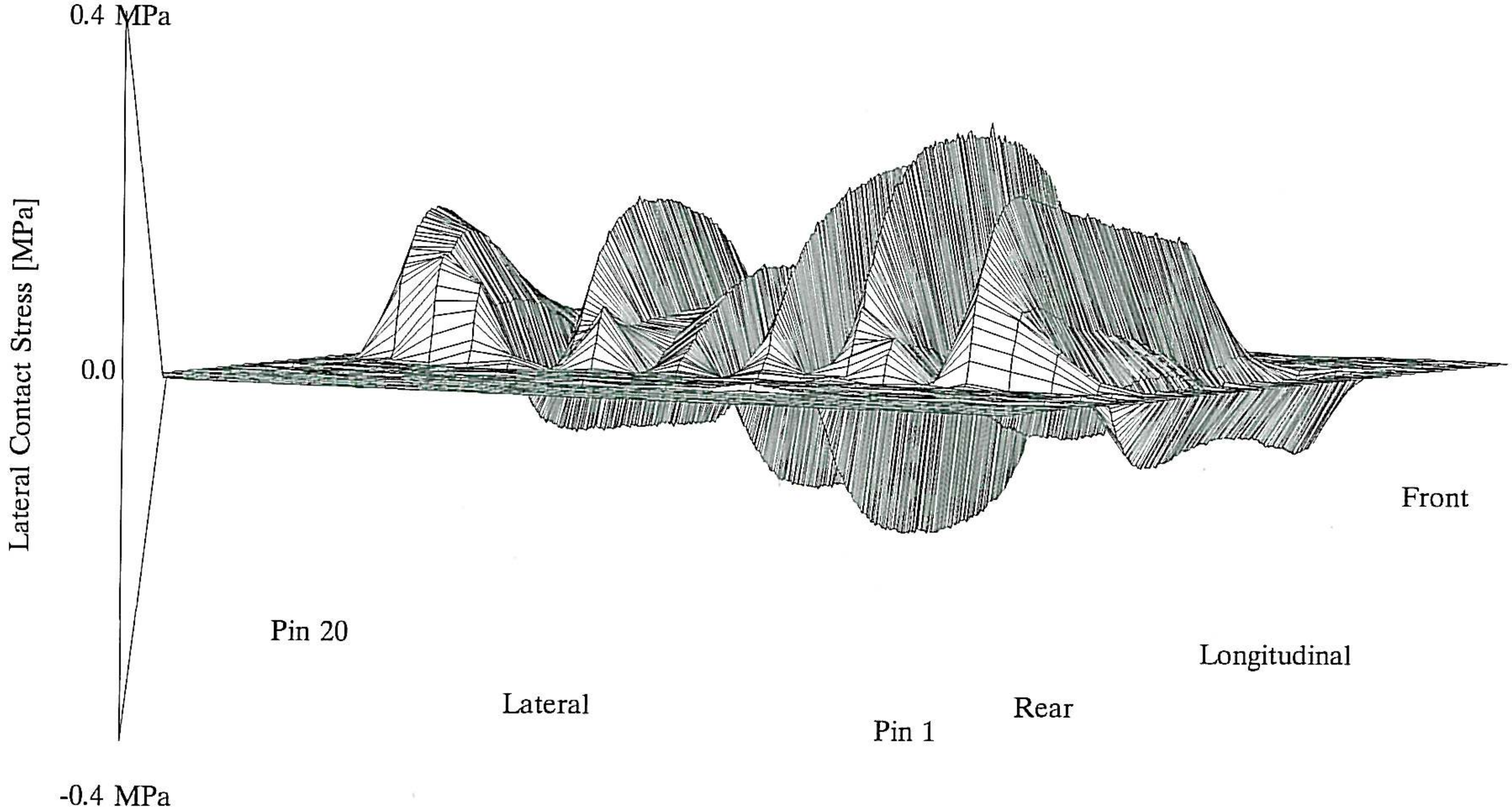
Used Bridgestone 425/65R22.5 R160AZ

FIGURE A10Z

Filename : noc907az

Applied Vertical Load (HVS) = 75 kN
Measured Lateral Load = 2.691 kN
Max. Stress = 0.2693 MPa
Min. Stress = -0.181 MPa

Inflation Press. = 900 kPa
Temperature = 25 deg.C
Wheel Speed = 0.305 m/s



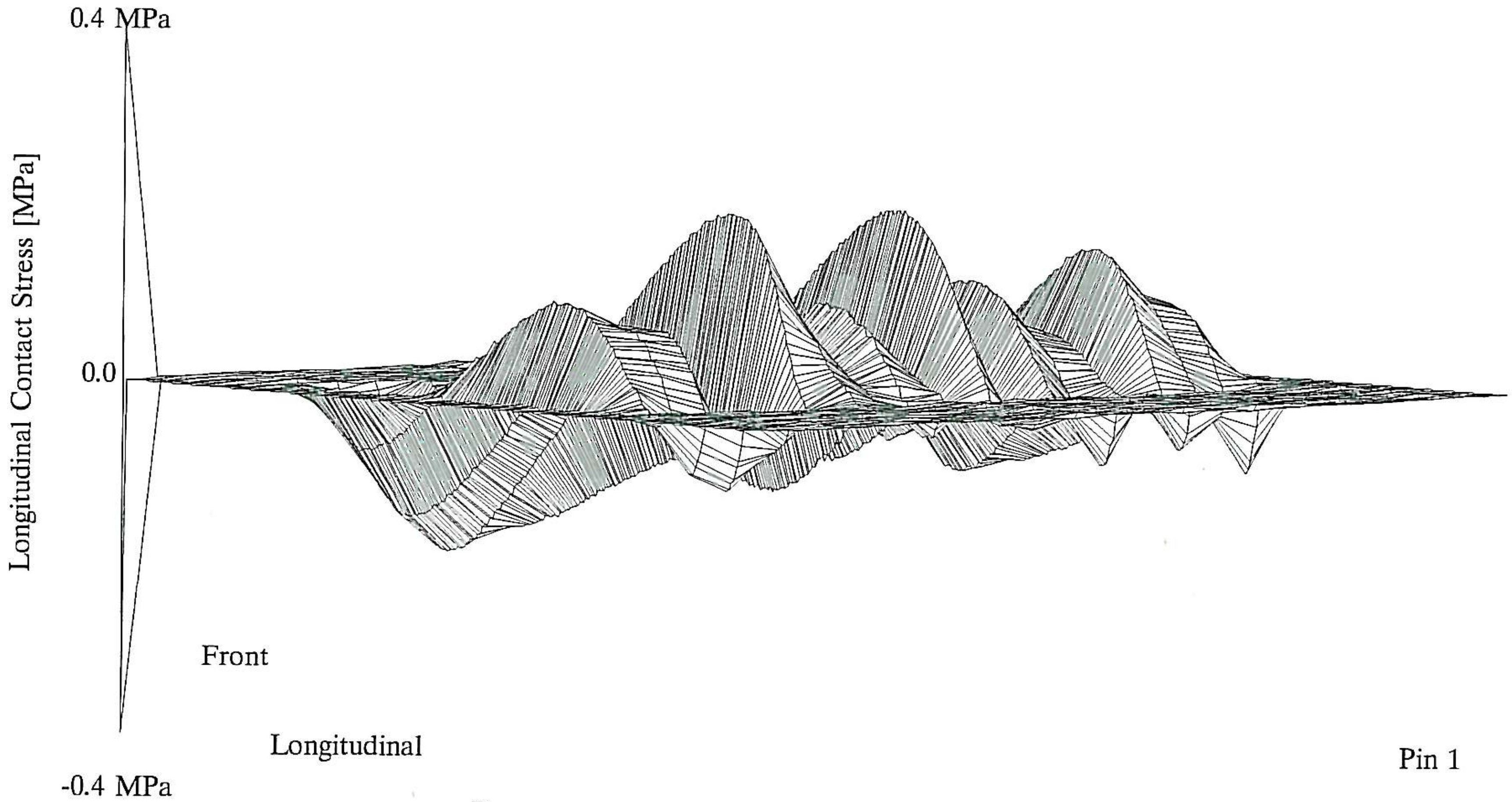
Filename : noc907ay

Used Bridgestone 425/65R22.5 R160AZ

FIGURE A10Y

Applied Vertical Load (HVS) = 75 kN
Measured Longitudinal Load = 0.3435 kN
Max. Stress = 0.2132 MPa
Min. Stress = -0.187 MPa

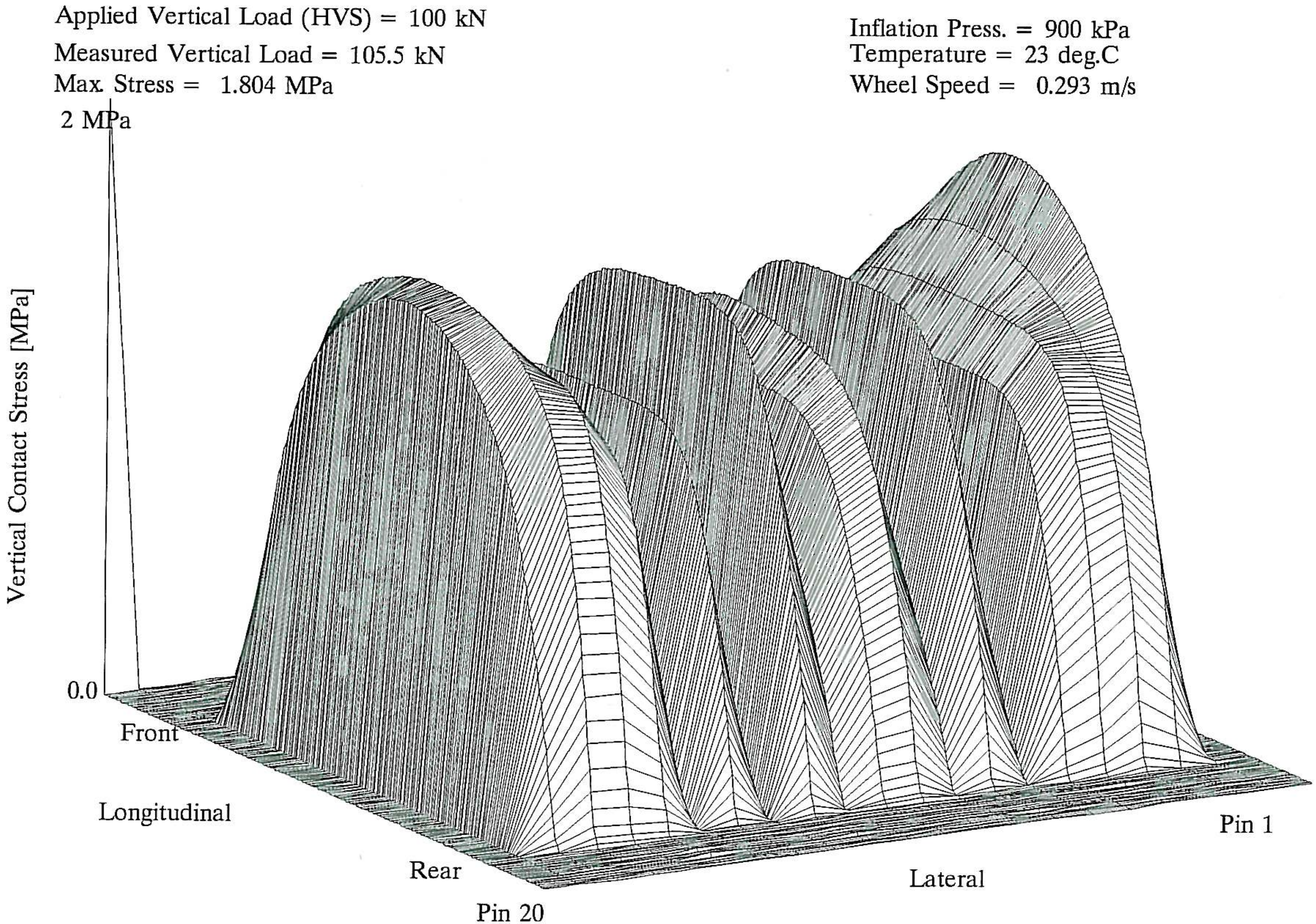
Inflation Press. = 900 kPa
Temperature = 25 deg.C
Wheel Speed = 0.305 m/s



Used Bridgestone 425/65R22.5 R160AZ

FIGURE A10X

Filename : noc907ax



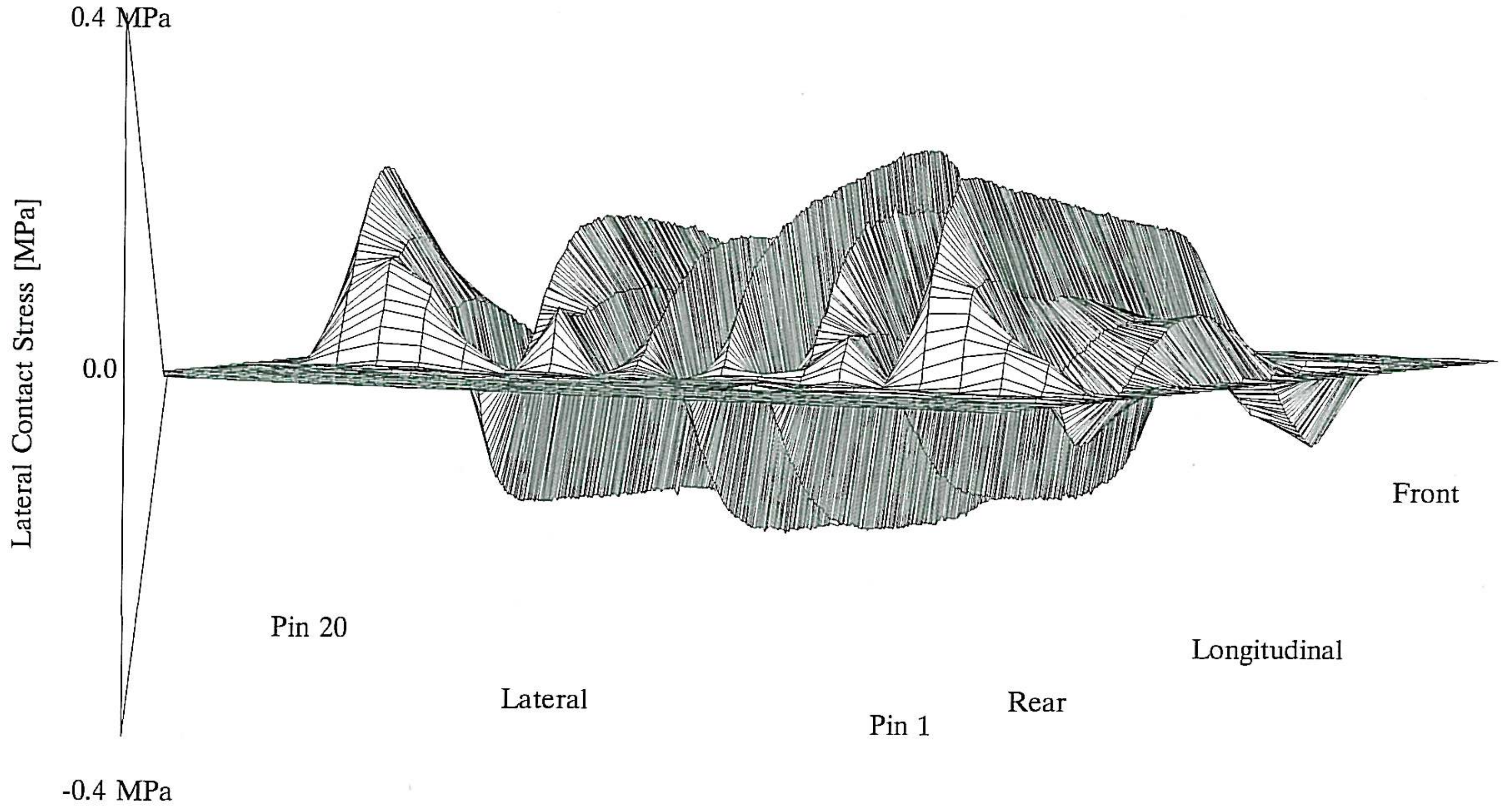
Used Bridgestone 425/65R22.5 R160AZ

Filename : noc901az

FIGURE A11Z

Applied Vertical Load (HVS) = 100 kN
Measured Lateral Load = 2.321 kN
Max. Stress = 0.2329 MPa
Min. Stress = -0.1835 MPa

Inflation Press. = 900 kPa
Temperature = 23 deg.C
Wheel Speed = 0.293 m/s



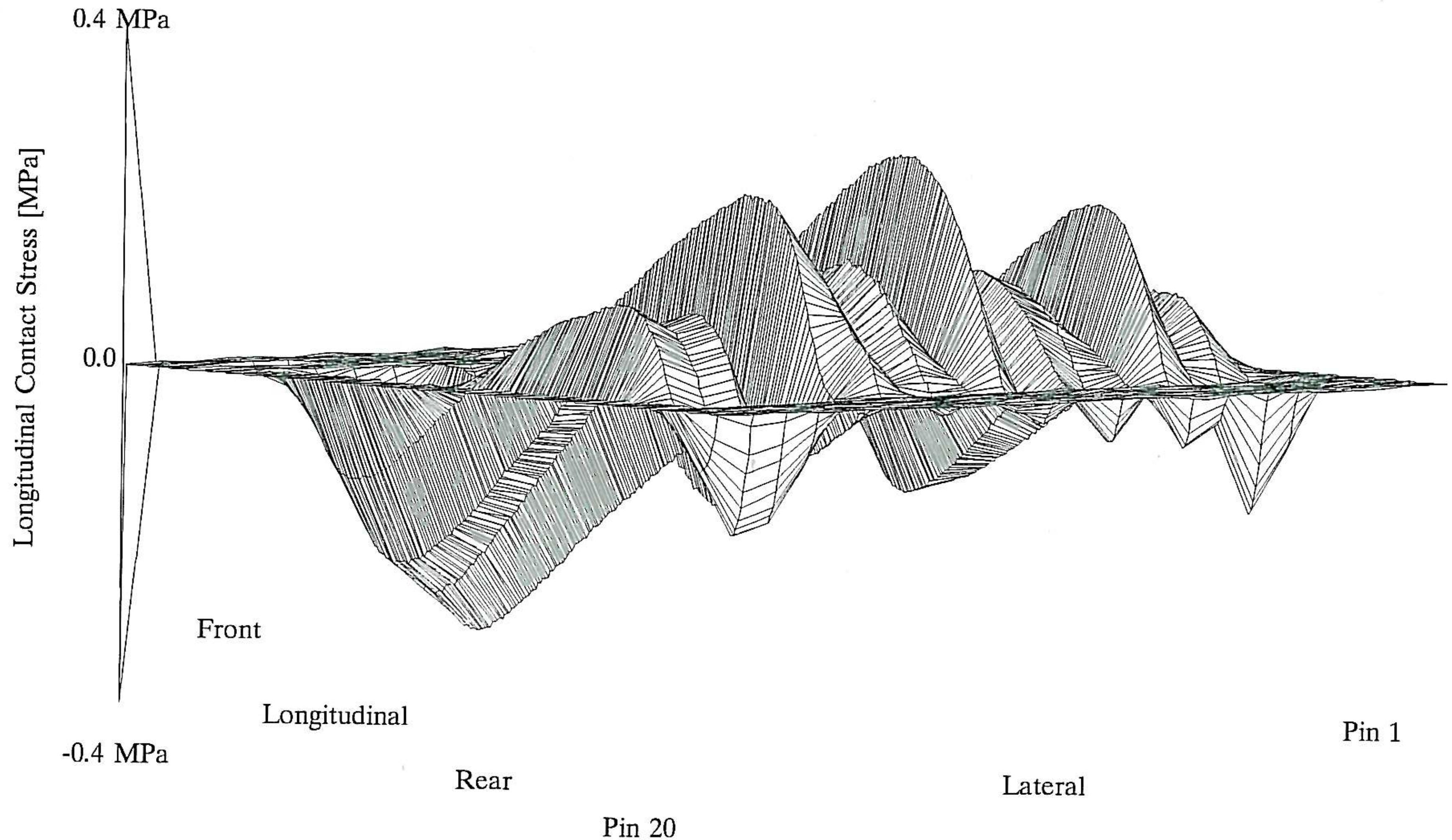
Used Bridgestone 425/65R22.5 R160AZ

FIGURE A11Y

Filename : noc901ay

Applied Vertical Load (HVS) = 100 kN
Measured Longitudinal Load = -0.3668 kN
Max. Stress = 0.2695 MPa
Min. Stress = -0.3045 MPa

Inflation Press. = 900 kPa
Temperature = 23 deg.C
Wheel Speed = 0.293 m/s



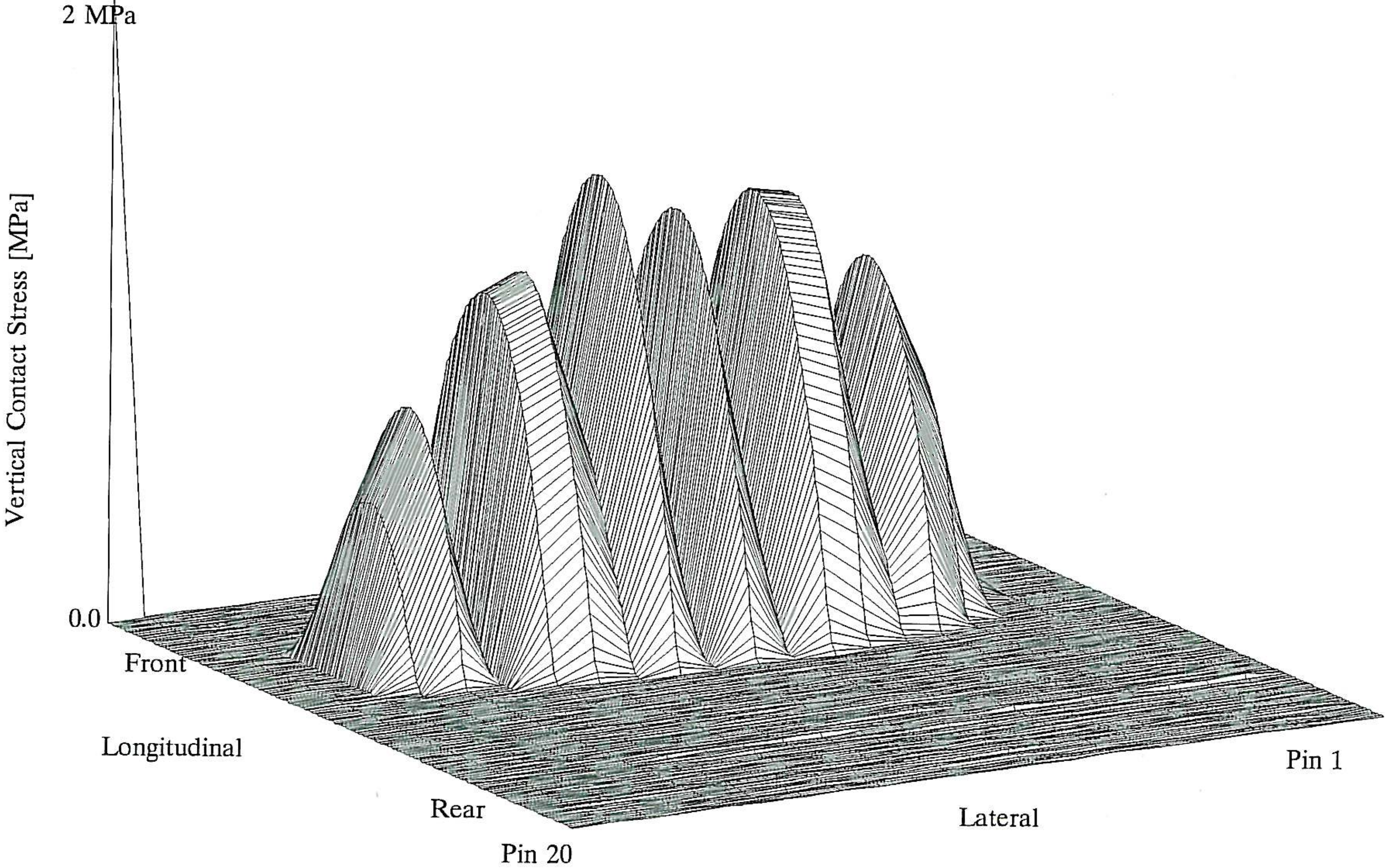
Used Bridgestone 425/65R22.5 R160AZ

Filename : noc901ax

FIGURE A11X

Applied Vertical Load (HVS) = 25 kN
Measured Vertical Load = 23.76 kN
Max. Stress = 1.469 MPa

Inflation Press. = 950 kPa
Temperature = 22 deg.C
Wheel Speed = 0.291 m/s



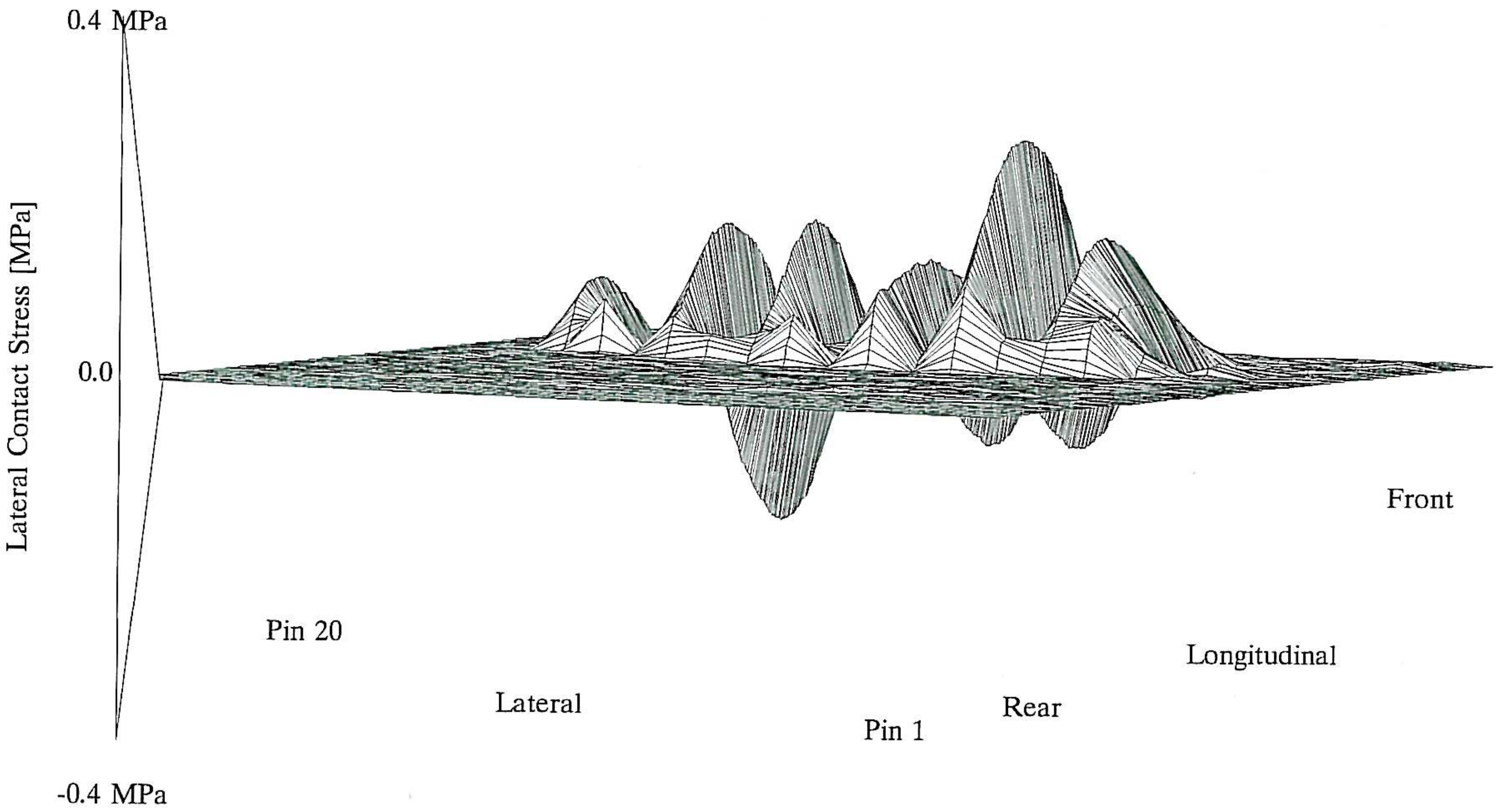
Used Bridgestone 425/65R22.5 R160AZ

FIGURE A12Z

Filename : nosc92az

Applied Vertical Load (HVS) = 25 kN
Measured Lateral Load = 1.076 kN
Max. Stress = 0.2488 MPa
Min. Stress = -0.1832 MPa

Inflation Press. = 950 kPa
Temperature = 22 deg.C
Wheel Speed = 0.291 m/s



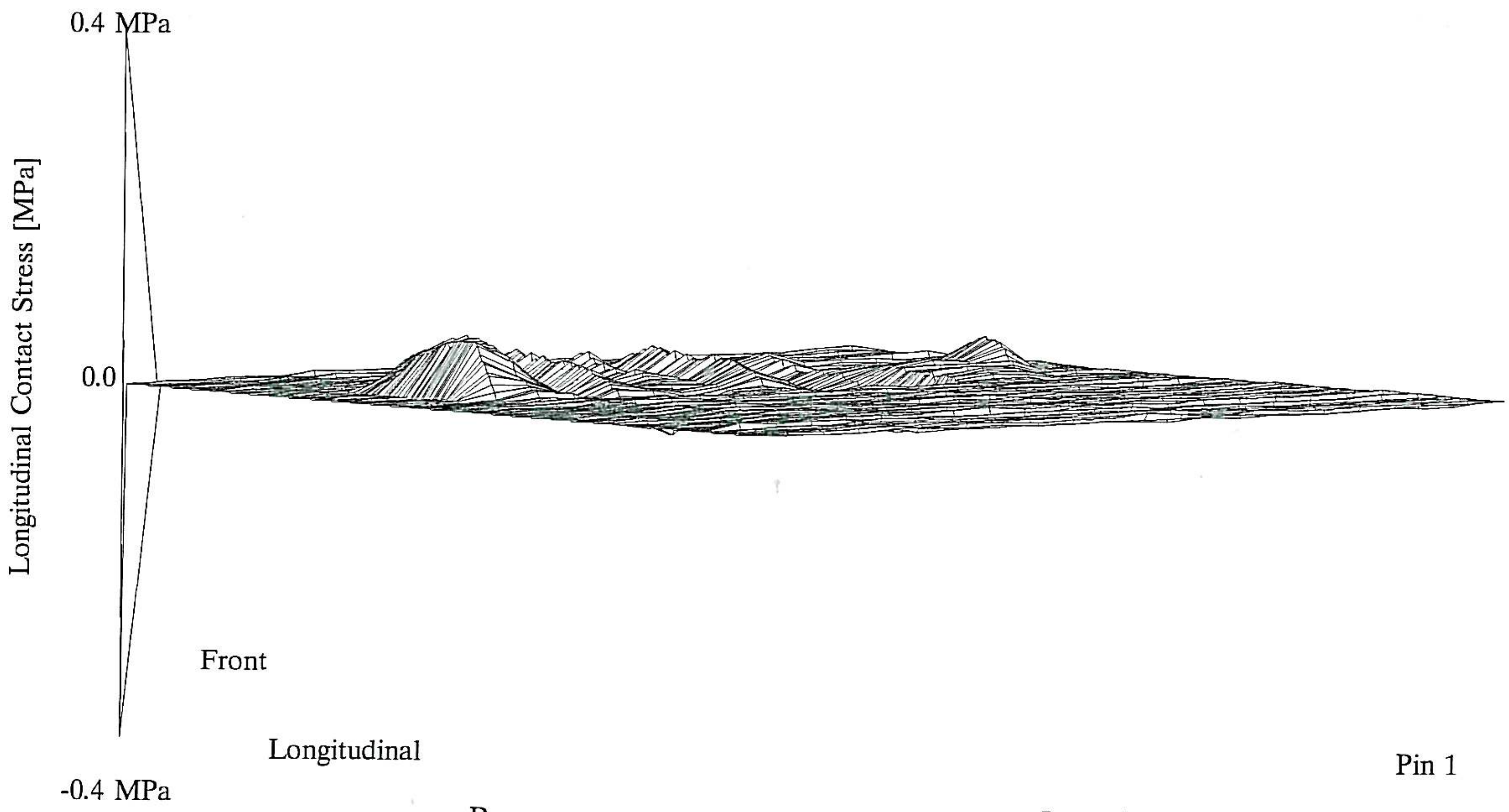
Used Bridgestone 425/65R22.5 R160AZ

FIGURE A12Y

Filename : nosc92ay

Applied Vertical Load (HVS) = 25 kN
Measured Longitudinal Load = 0.2121 kN
Max. Stress = 0.06669 MPa
Min. Stress = -0.05306 MPa

Inflation Press. = 950 kPa
Temperature = 22 deg.C
Wheel Speed = 0.291 m/s



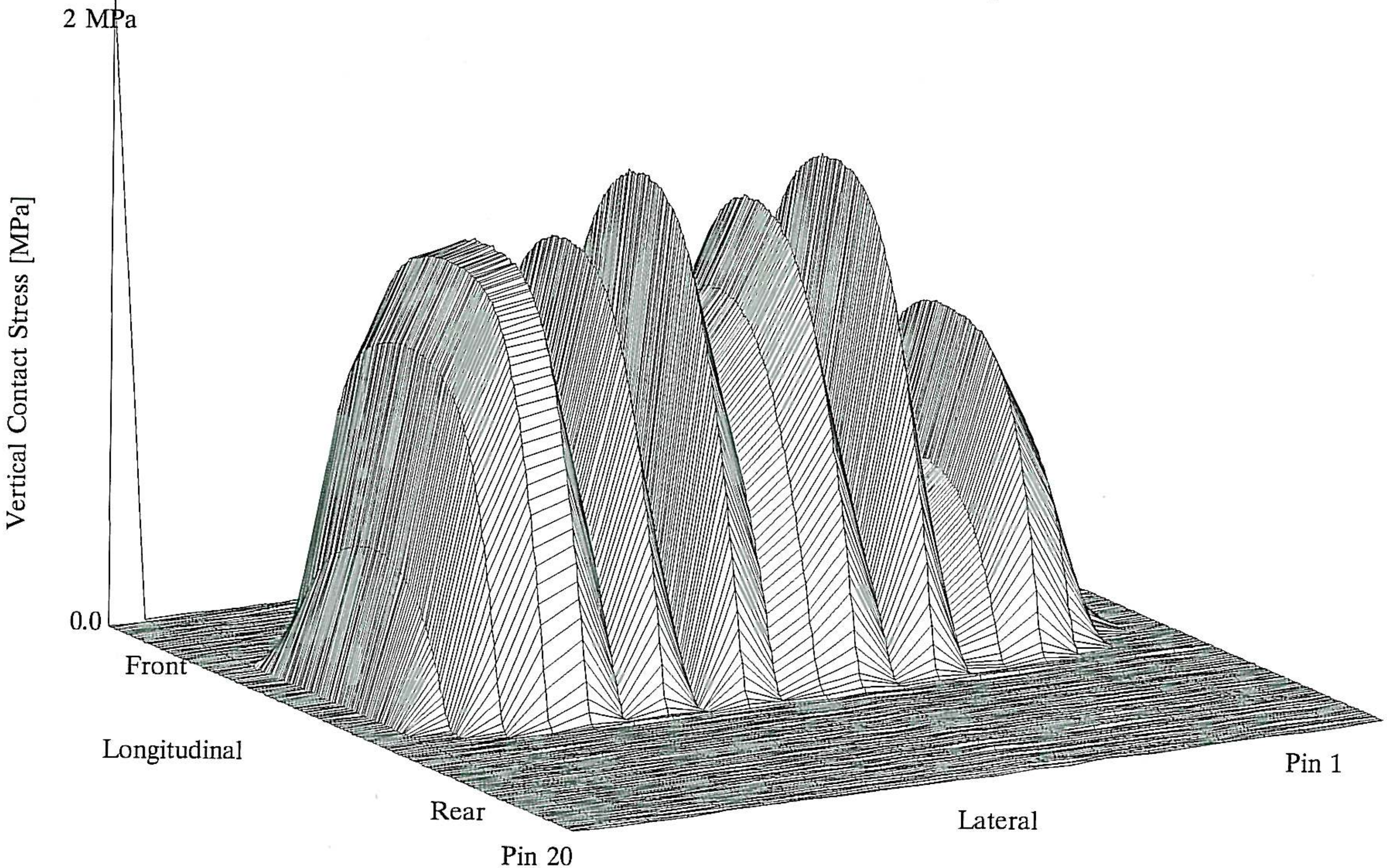
Used Bridgestone 425/65R22.5 R160AZ

FIGURE A12X

Filename : nosc92ax

Applied Vertical Load (HVS) = 50 kN
Measured Vertical Load = 46.08 kN
Max. Stress = 1.543 MPa

Inflation Press. = 950 kPa
Temperature = 20 deg.C
Wheel Speed = 0.296 m/s



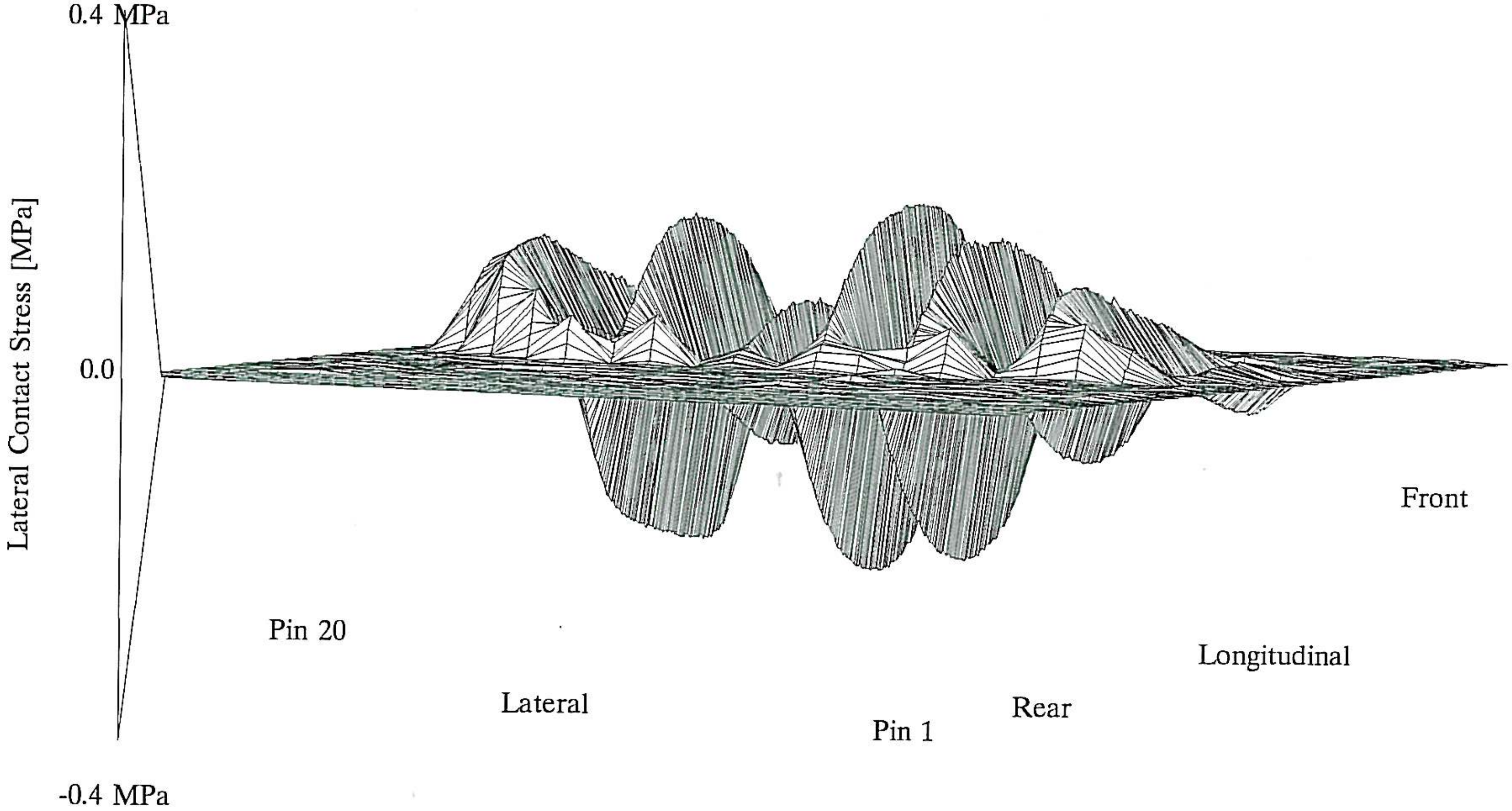
Used Bridgestone 425/65R22.5 R160AZ

Filename : nosc95az

FIGURE A13Z

Applied Vertical Load (HVS) = 50 kN
Measured Lateral Load = -0.1723 kN
Max. Stress = 0.1744 MPa
Min. Stress = -0.2305 MPa

Inflation Press. = 950 kPa
Temperature = 20 deg.C
Wheel Speed = 0.296 m/s



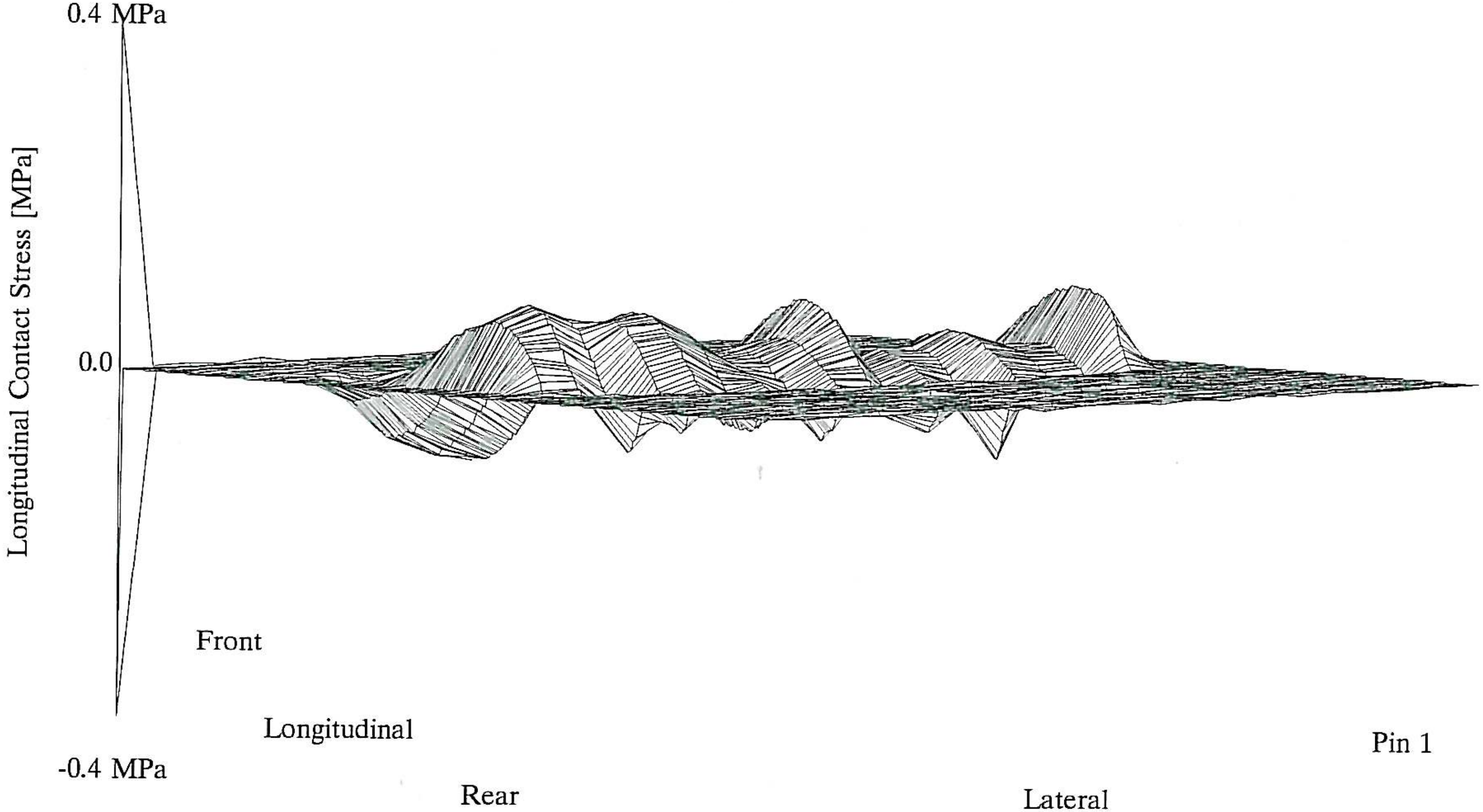
Used Bridgestone 425/65R22.5 R160AZ

FIGURE A13Y

Filename : nosc95ay

Applied Vertical Load (HVS) = 50 kN
Measured Longitudinal Load = 0.05191 kN
Max. Stress = 0.09721 MPa
Min. Stress = -0.09817 MPa

Inflation Press. = 950 kPa
Temperature = 20 deg.C
Wheel Speed = 0.296 m/s



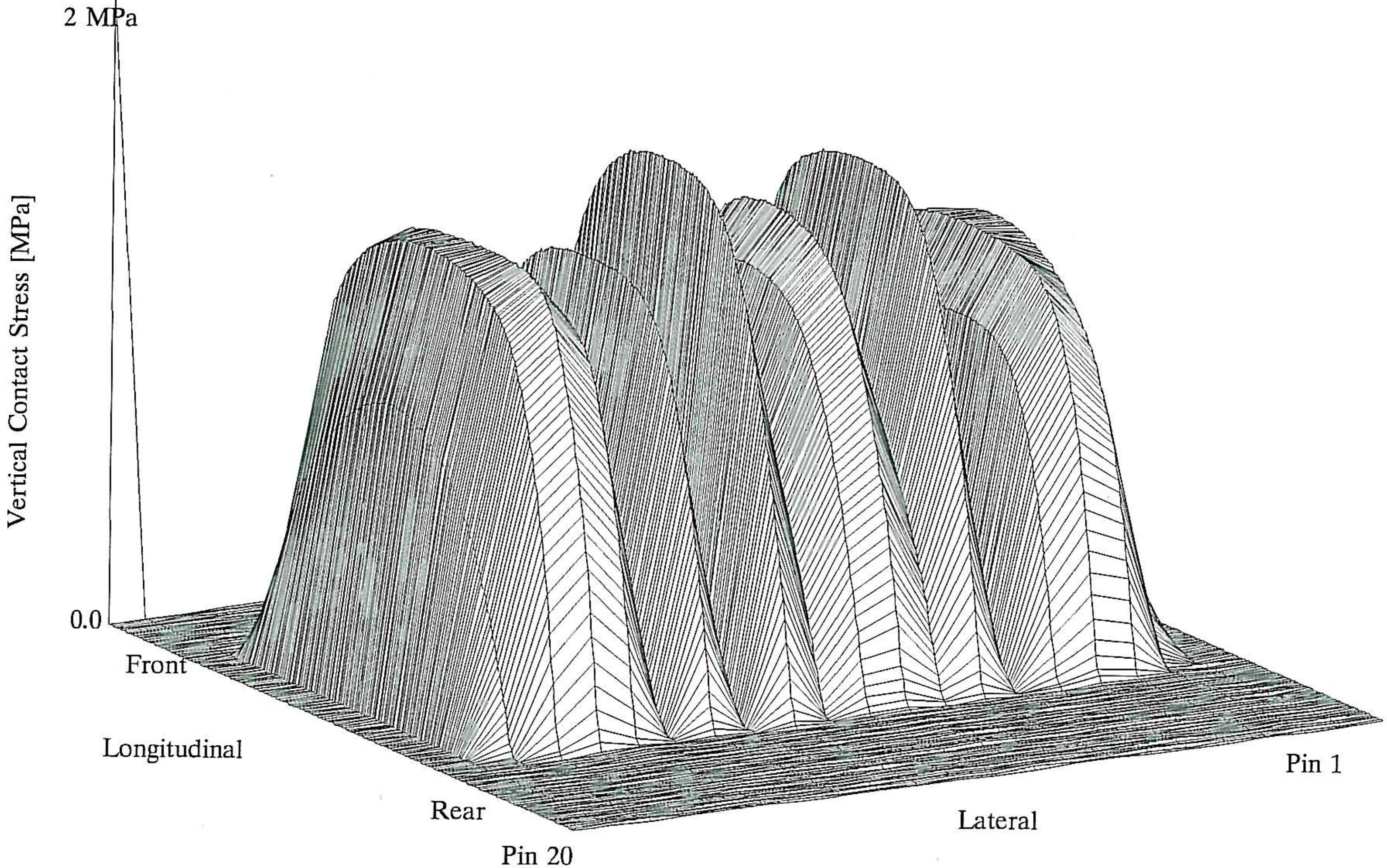
Used Bridgestone 425/65R22.5 R160AZ

Filename : nosc95ax

FIGURE A13X

Applied Vertical Load (HVS) = 75 kN
Measured Vertical Load = 75.09 kN
Max. Stress = 1.624 MPa

Inflation Press. = 950 kPa
Temperature = 19 deg.C
Wheel Speed = 0.309 m/s



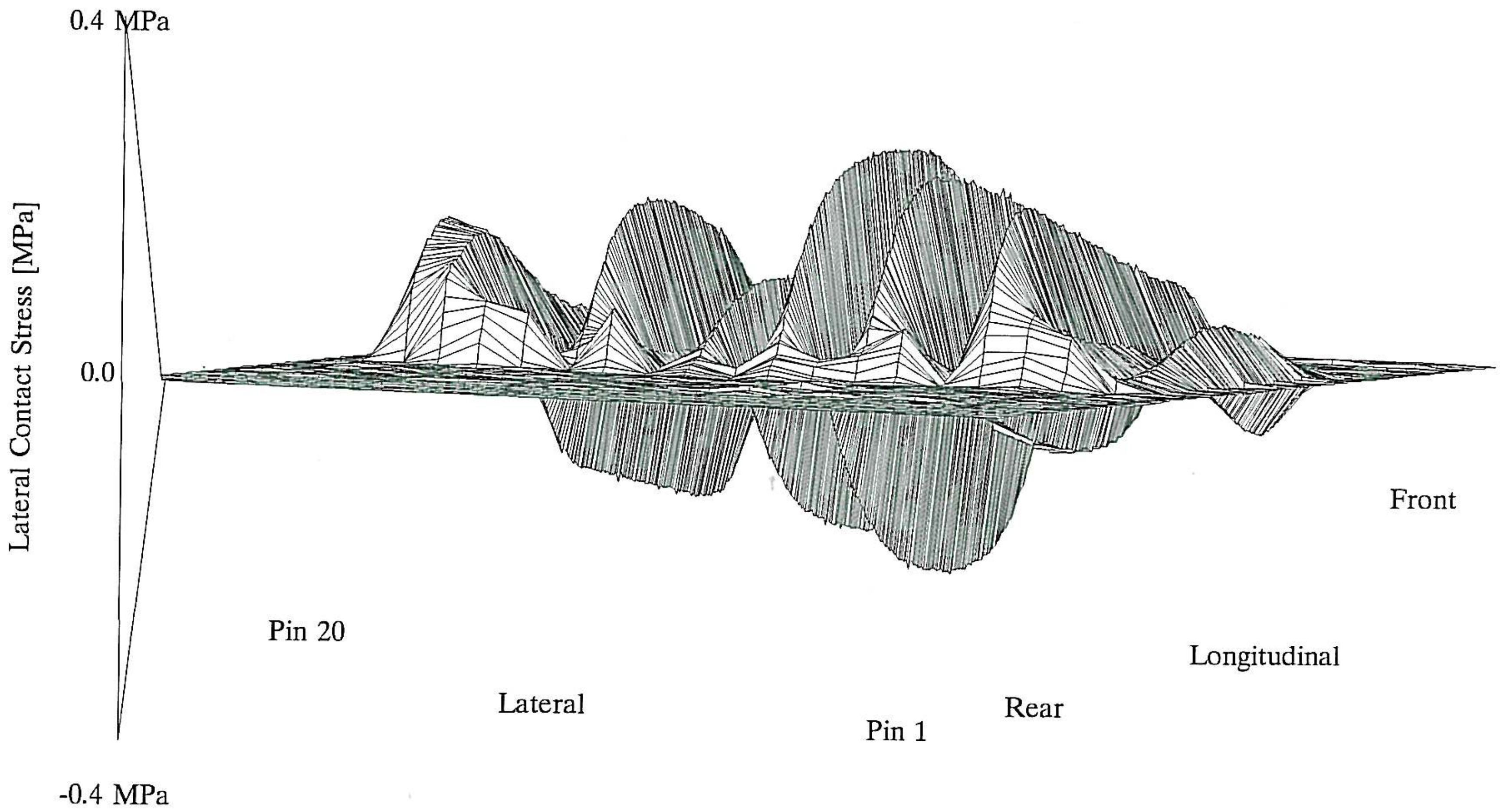
Used Bridgestone 425/65R22.5 R160AZ

Filename : nosc97az

FIGURE A14Z

Applied Vertical Load (HVS) = 75 kN
Measured Lateral Load = 1.474 kN
Max. Stress = 0.2408 MPa
Min. Stress = -0.2282 MPa

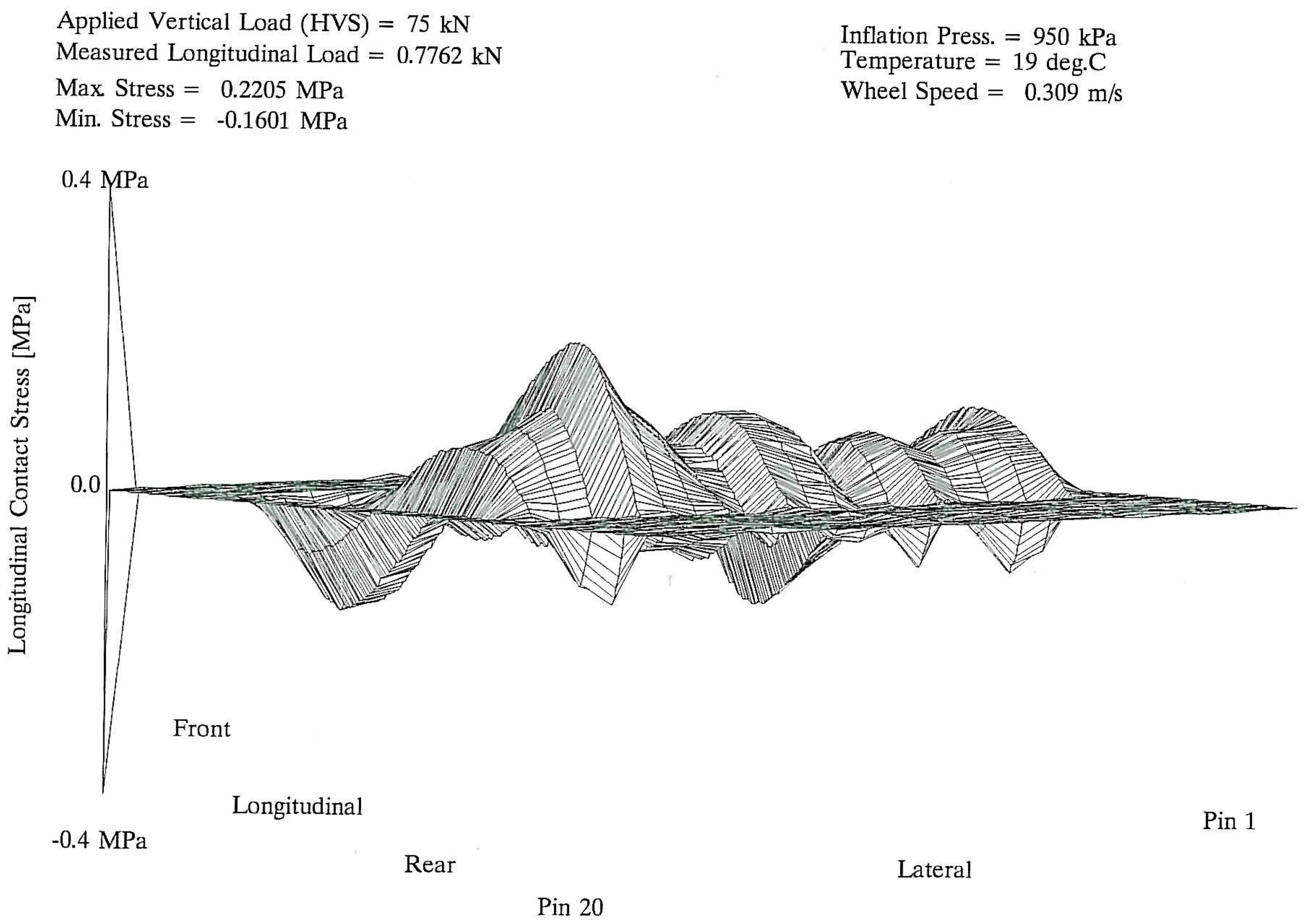
Inflation Press. = 950 kPa
Temperature = 19 deg.C
Wheel Speed = 0.309 m/s



Used Bridgestone 425/65R22.5 R160AZ

FIGURE A14Y

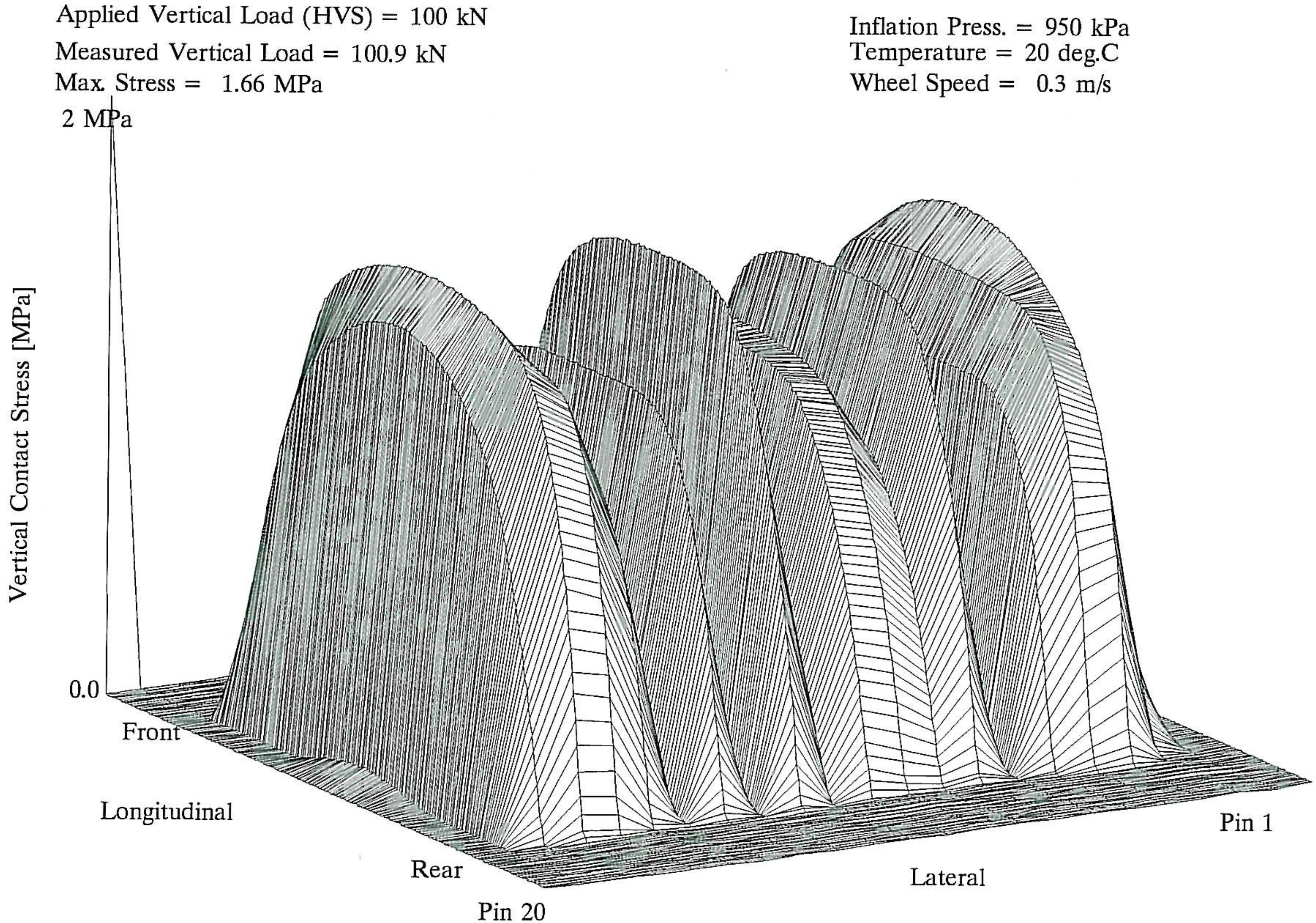
Filename : nosc97ay



Used Bridgestone 425/65R22.5 R160AZ

Filename : nosc97ax

FIGURE A14X



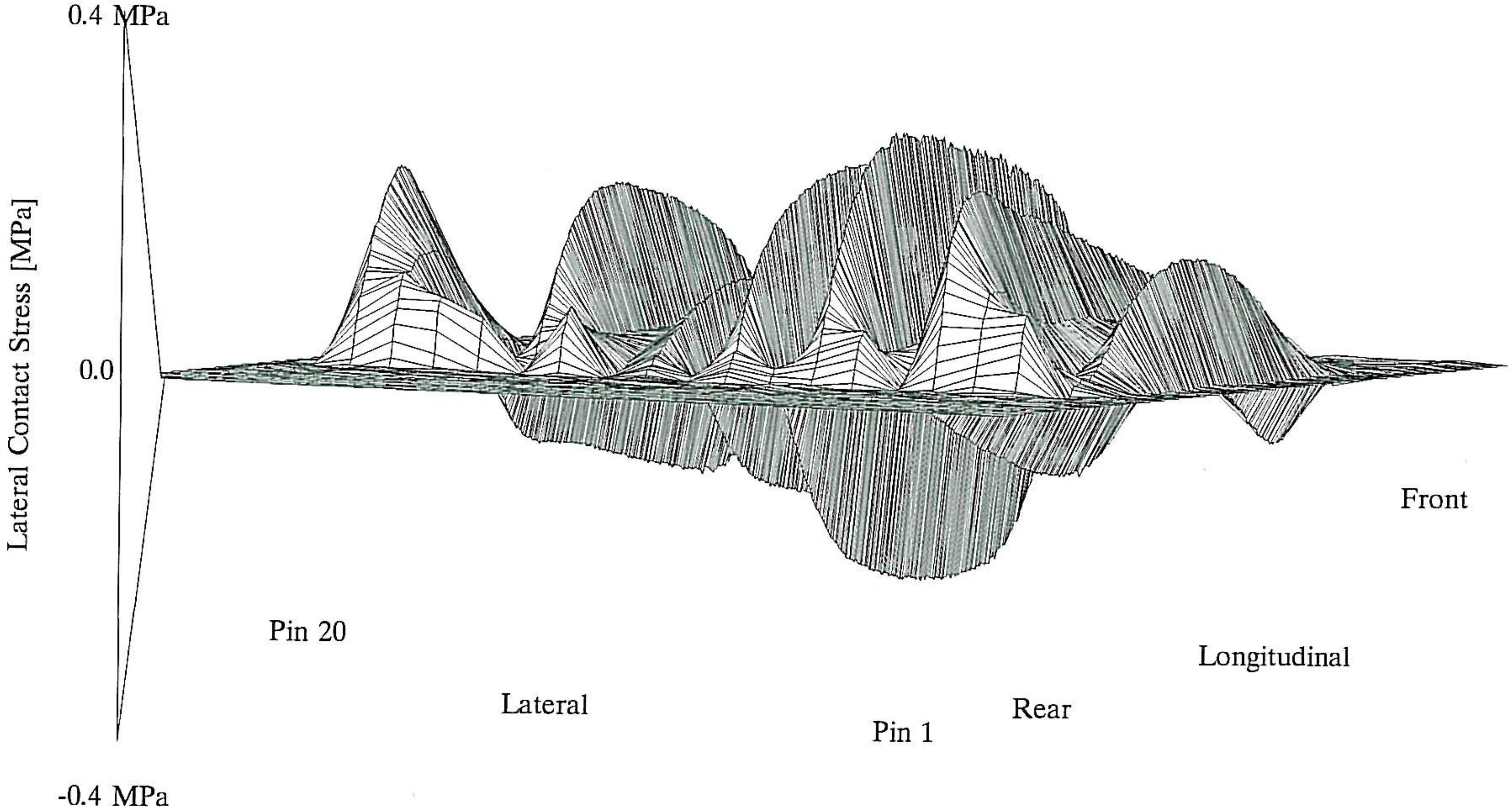
Used Bridgestone 425/65R22.5 R160AZ

Filename : nosc91az

FIGURE A15Z

Applied Vertical Load (HVS) = 100 kN
Measured Lateral Load = 2.899 kN
Max. Stress = 0.2689 MPa
Min. Stress = -0.2338 MPa

Inflation Press. = 950 kPa
Temperature = 20 deg.C
Wheel Speed = 0.3 m/s



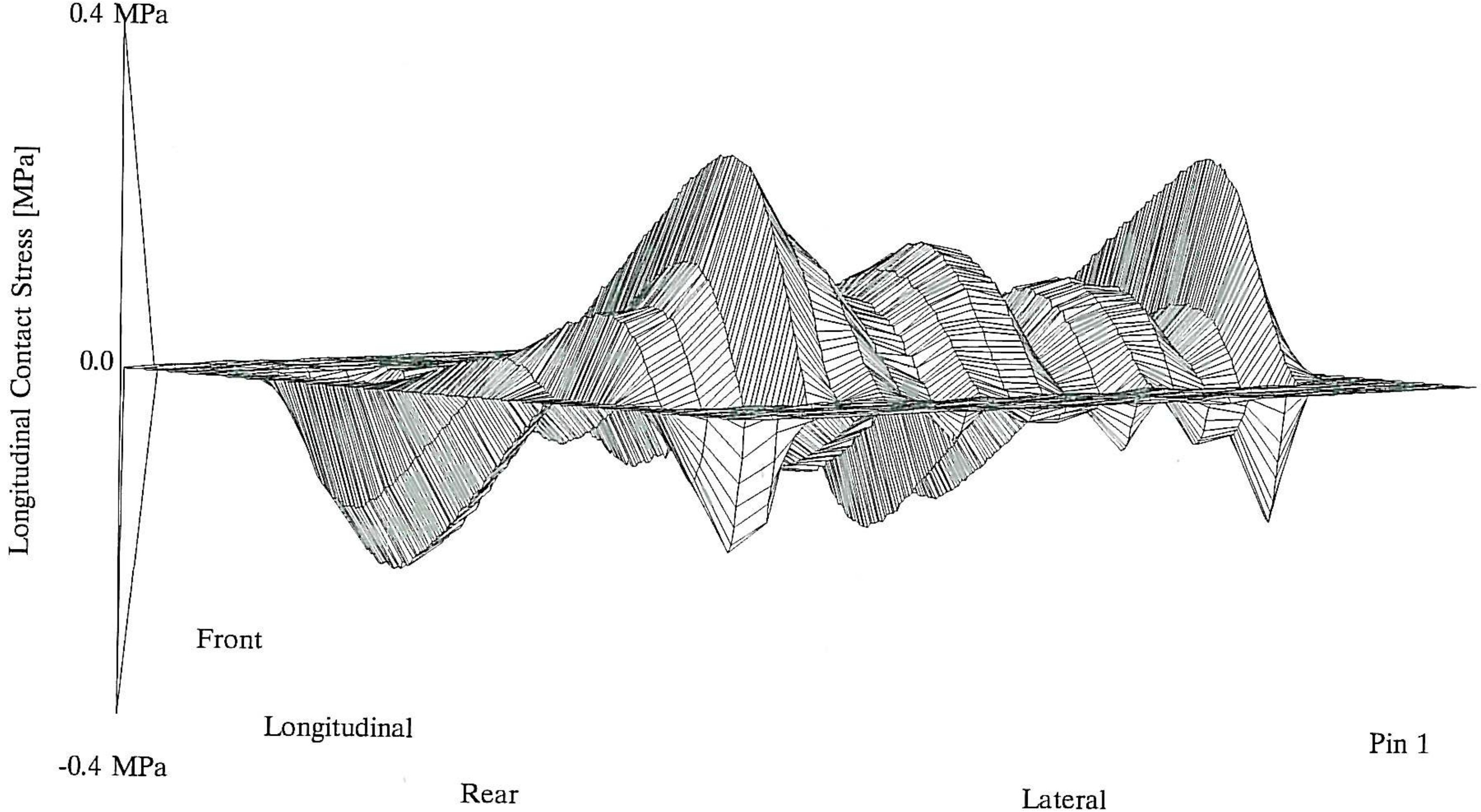
Used Bridgestone 425/65R22.5 R160AZ

Filename : nosc91ay

FIGURE A15Y

Applied Vertical Load (HVS) = 100 kN
Measured Longitudinal Load = 1.295 kN
Max. Stress = 0.2789 MPa
Min. Stress = -0.223 MPa

Inflation Press. = 950 kPa
Temperature = 20 deg.C
Wheel Speed = 0.3 m/s



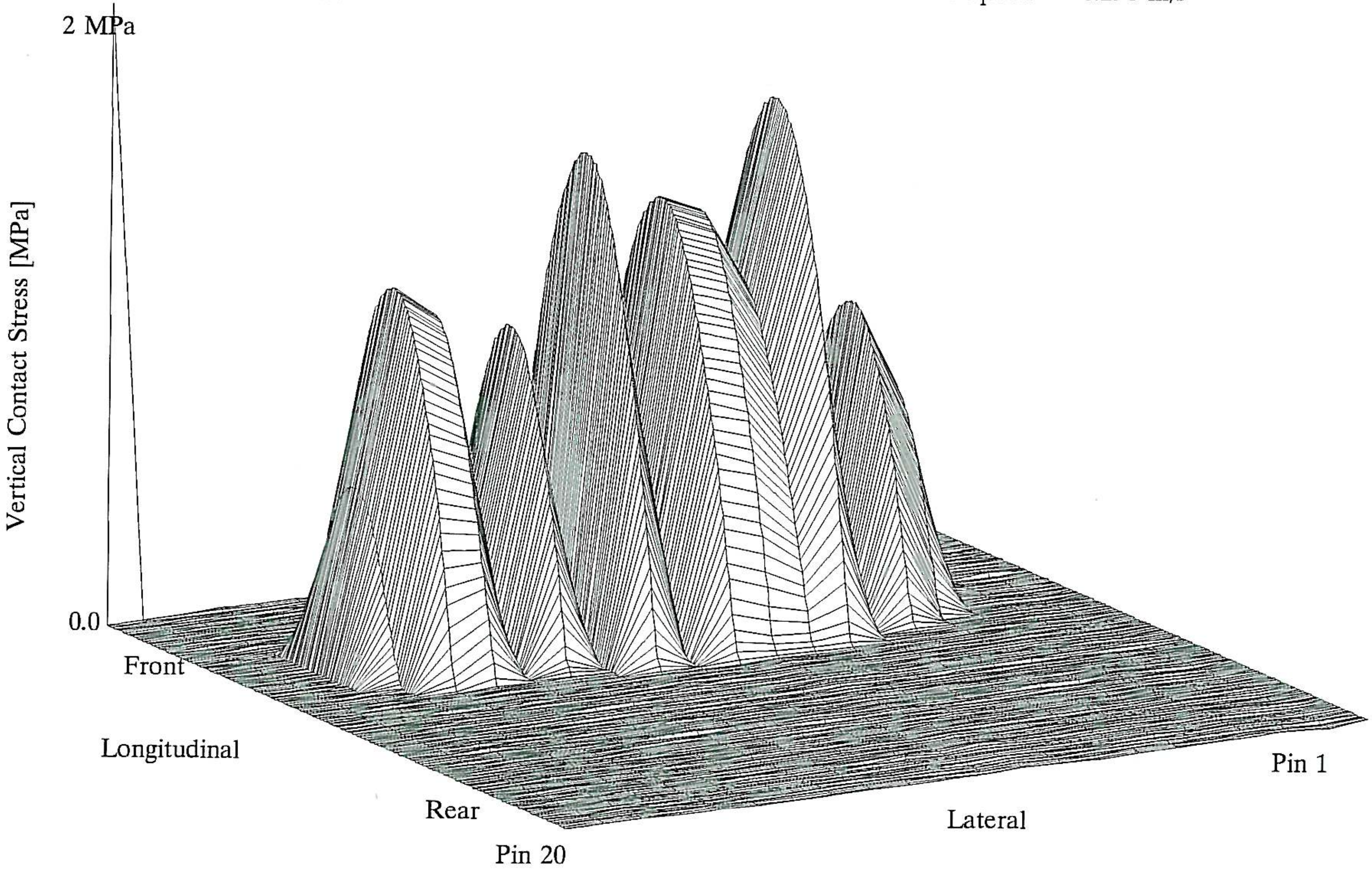
Used Bridgestone 425/65R22.5 R160AZ

Filename : nosc91ax

FIGURE A15X

Applied Vertical Load (HVS) = 25 kN
Measured Vertical Load = 22.7 kN
Max. Stress = 1.653 MPa

Inflation Press. = 1100 kPa
Temperature = 16 deg.C
Wheel Speed = 0.296 m/s



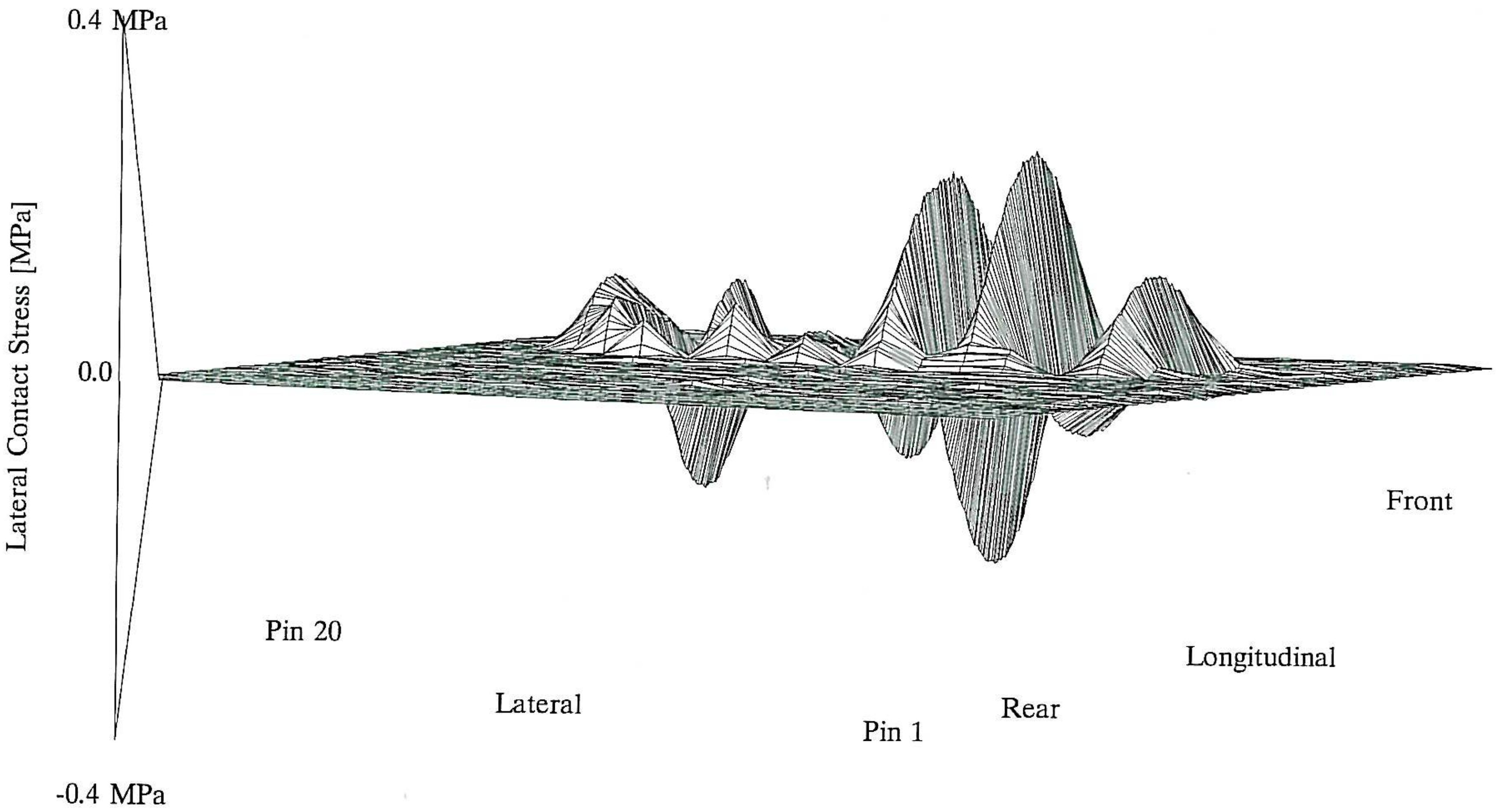
Used Bridgestone 425/65R22.5 R160AZ

Filename : nosc12az

FIGURE A16Z

Applied Vertical Load (HVS) = 25 kN
Measured Lateral Load = 0.3687 kN
Max. Stress = 0.2369 MPa
Min. Stress = -0.2211 MPa

Inflation Press. = 1100 kPa
Temperature = 16 deg.C
Wheel Speed = 0.296 m/s



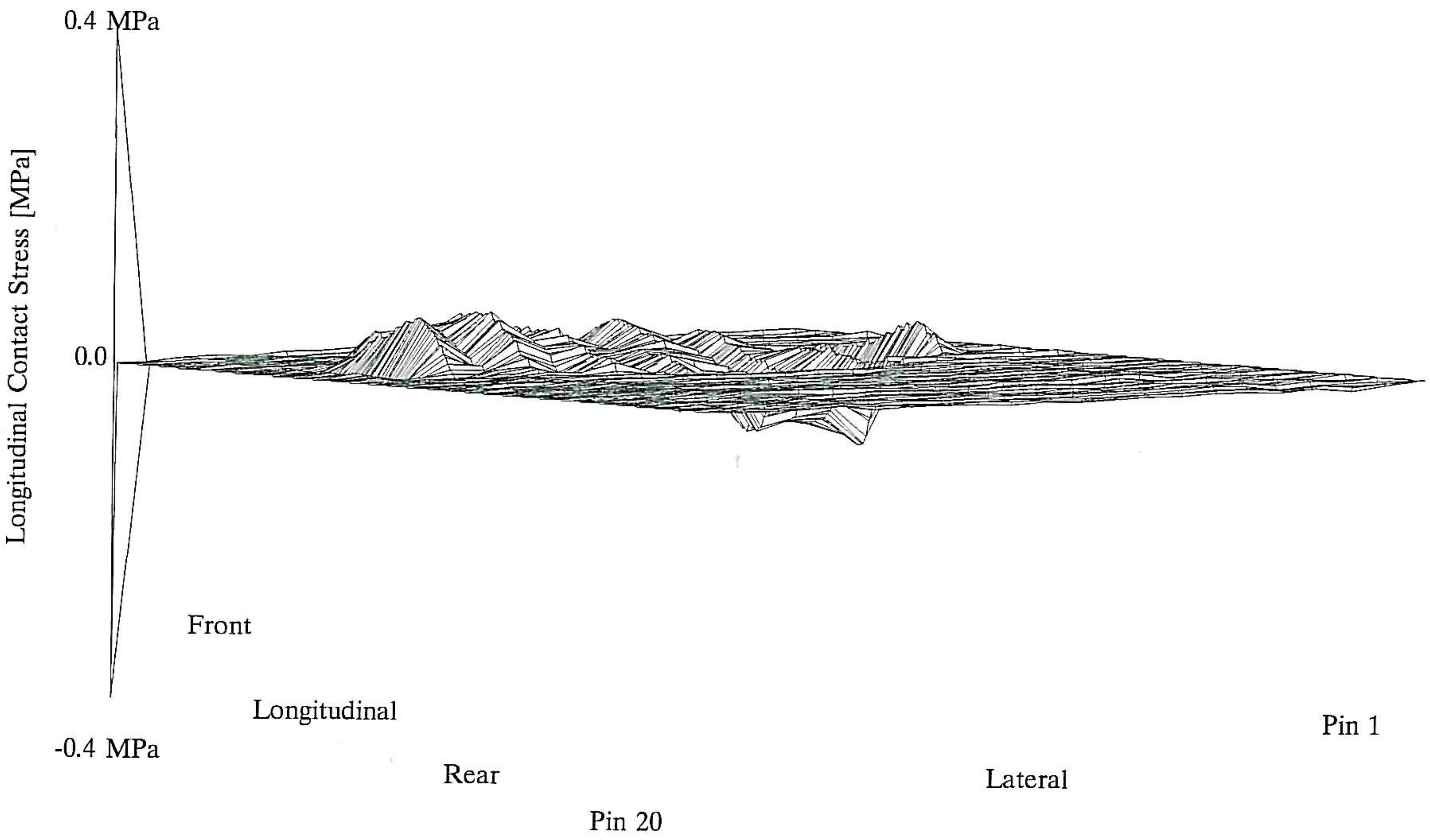
Used Bridgestone 425/65R22.5 R160AZ

FIGURE A16Y

Filename : nosc12ay

Applied Vertical Load (HVS) = 25 kN
Measured Longitudinal Load = -0.1362 kN
Max. Stress = 0.07252 MPa
Min. Stress = -0.09669 MPa

Inflation Press. = 1100 kPa
Temperature = 16 deg.C
Wheel Speed = 0.296 m/s



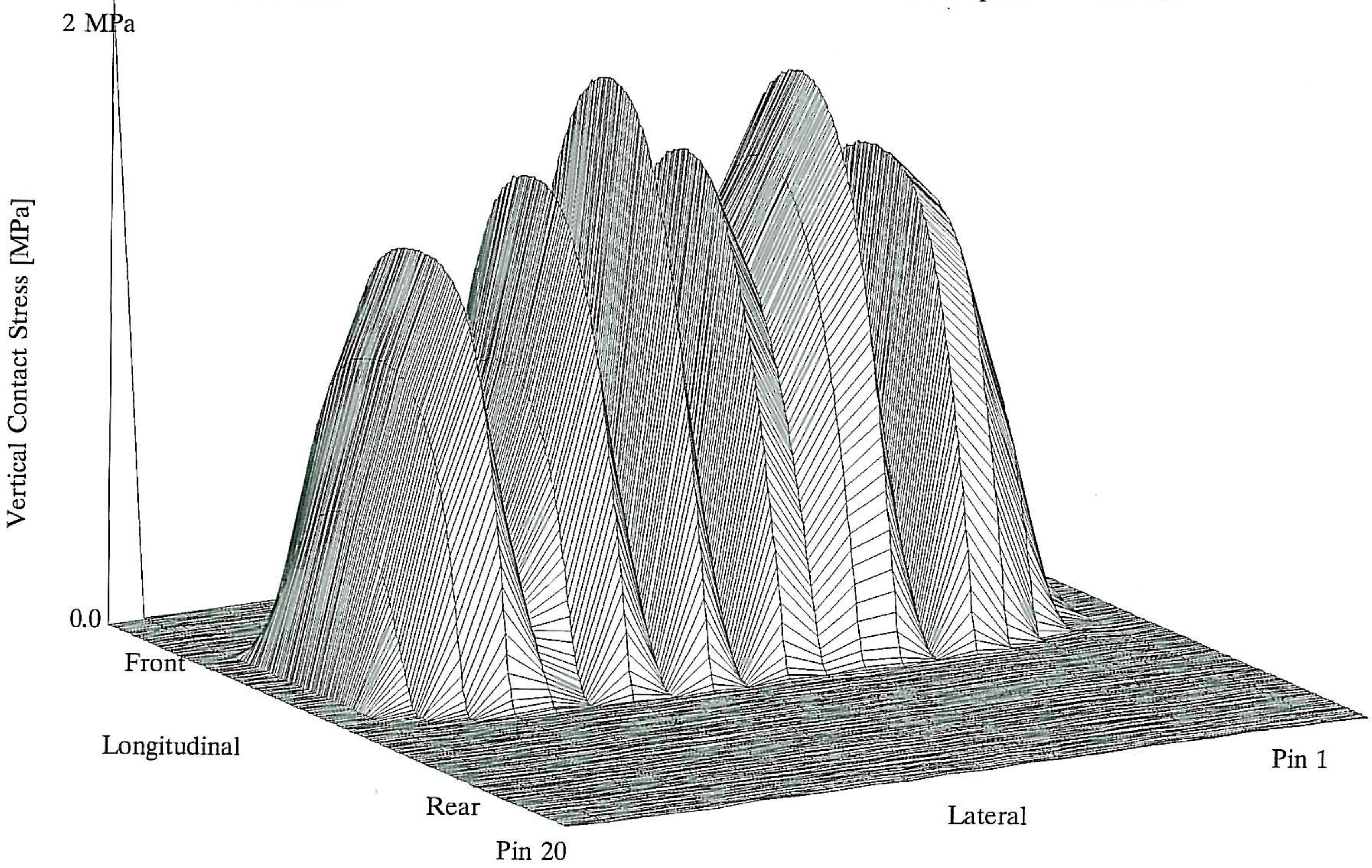
Used Bridgestone 425/65R22.5 R160AZ

Filename : nosc12ax

FIGURE A16X

Applied Vertical Load (HVS) = 50 kN
Measured Vertical Load = 47.75 kN
Max. Stress = 1.819 MPa

Inflation Press. = 1100 kPa
Temperature = 19 deg.C
Wheel Speed = 0.281 m/s



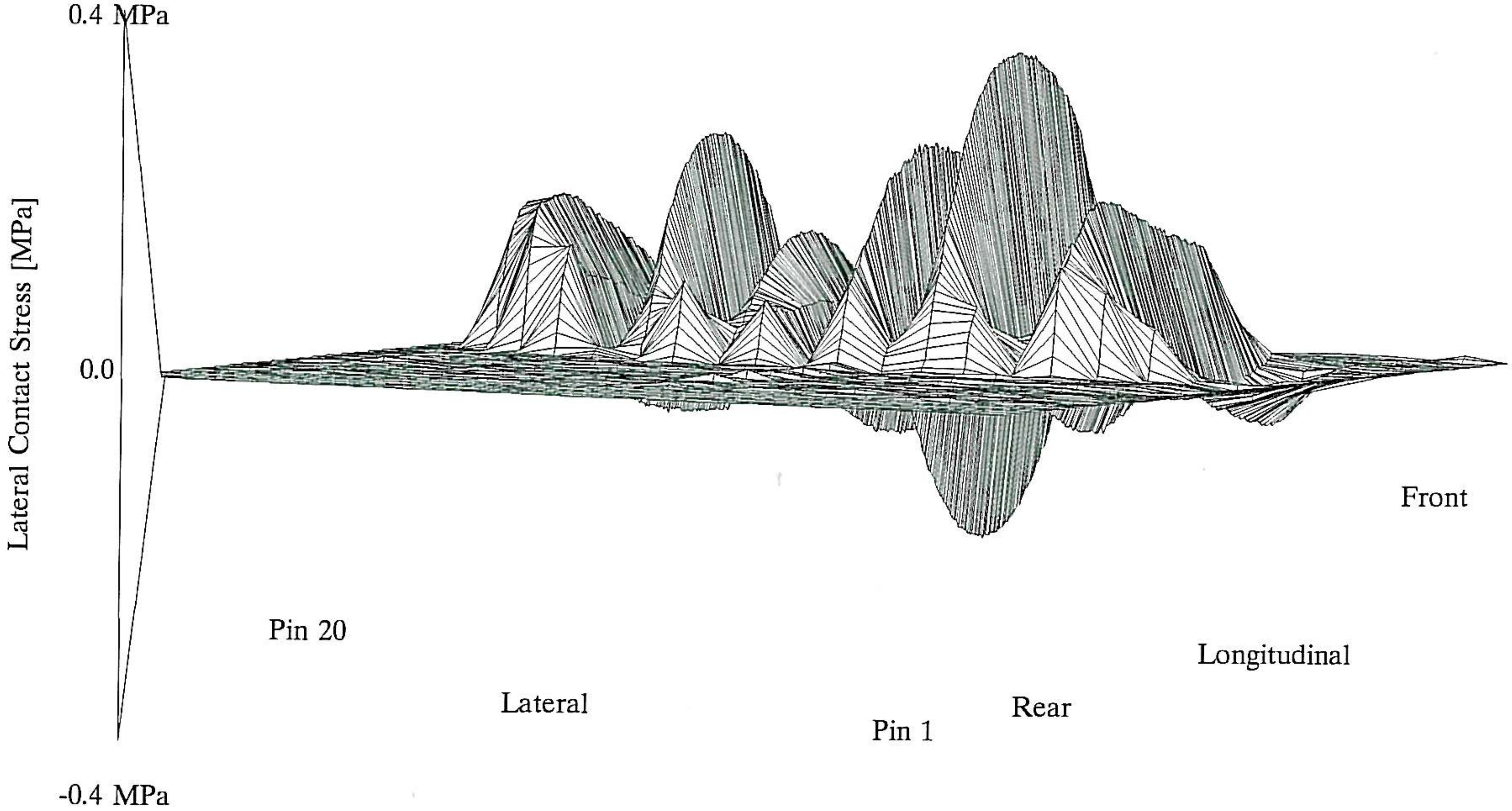
Used Bridgestone 425/65R22.5 R160AZ

FIGURE A17Z

Filename : nosc15az

Applied Vertical Load (HVS) = 50 kN
Measured Lateral Load = 2.807 kN
Max. Stress = 0.3419 MPa
Min. Stress = -0.1944 MPa

Inflation Press. = 1100 kPa
Temperature = 19 deg.C
Wheel Speed = 0.281 m/s



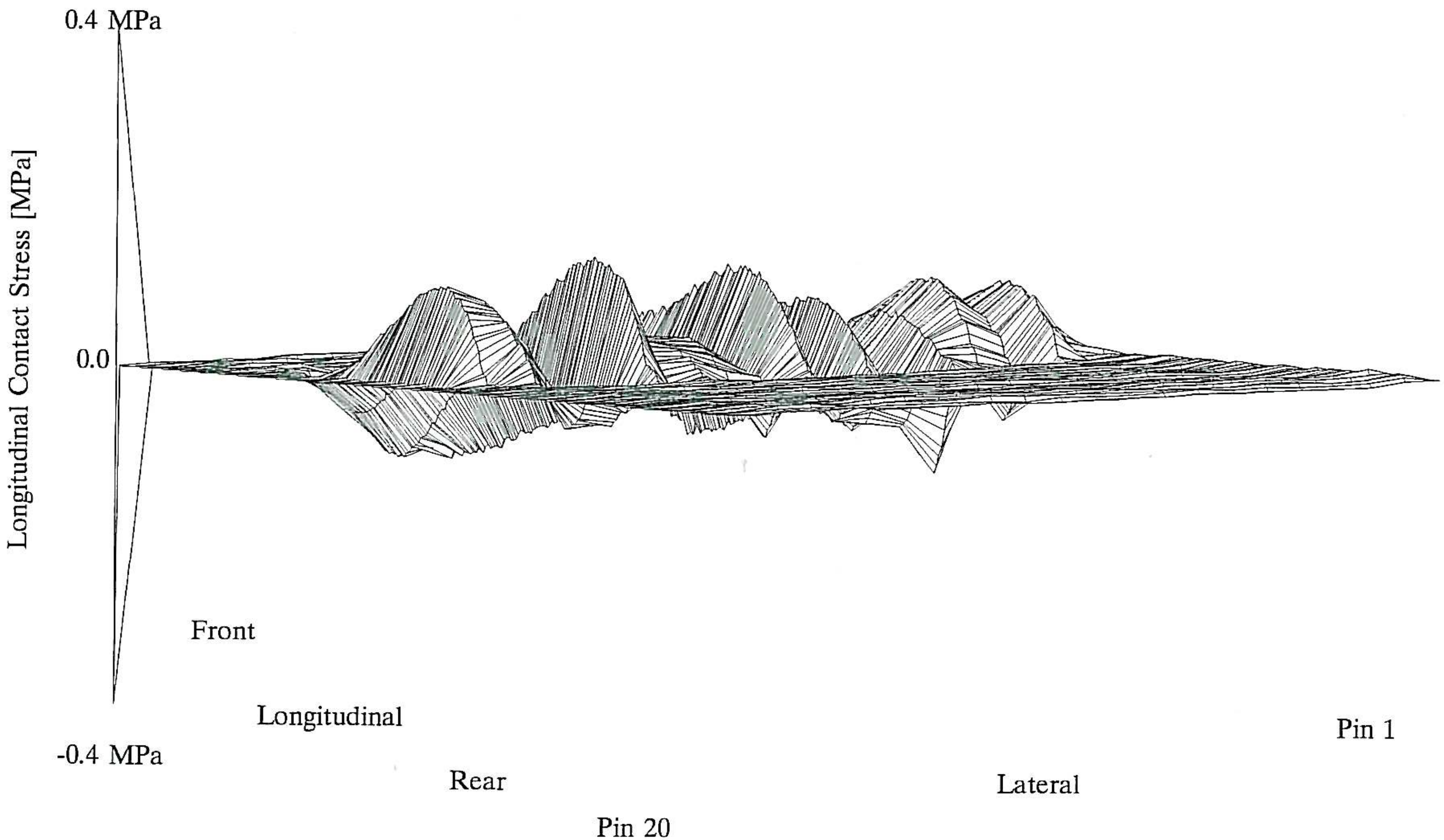
Used Bridgestone 425/65R22.5 R160AZ

FIGURE A17Y

Filename : nosc15ay

Applied Vertical Load (HVS) = 50 kN
Measured Longitudinal Load = 0.4737 kN
Max. Stress = 0.1433 MPa
Min. Stress = -0.1212 MPa

Inflation Press. = 1100 kPa
Temperature = 19 deg.C
Wheel Speed = 0.281 m/s



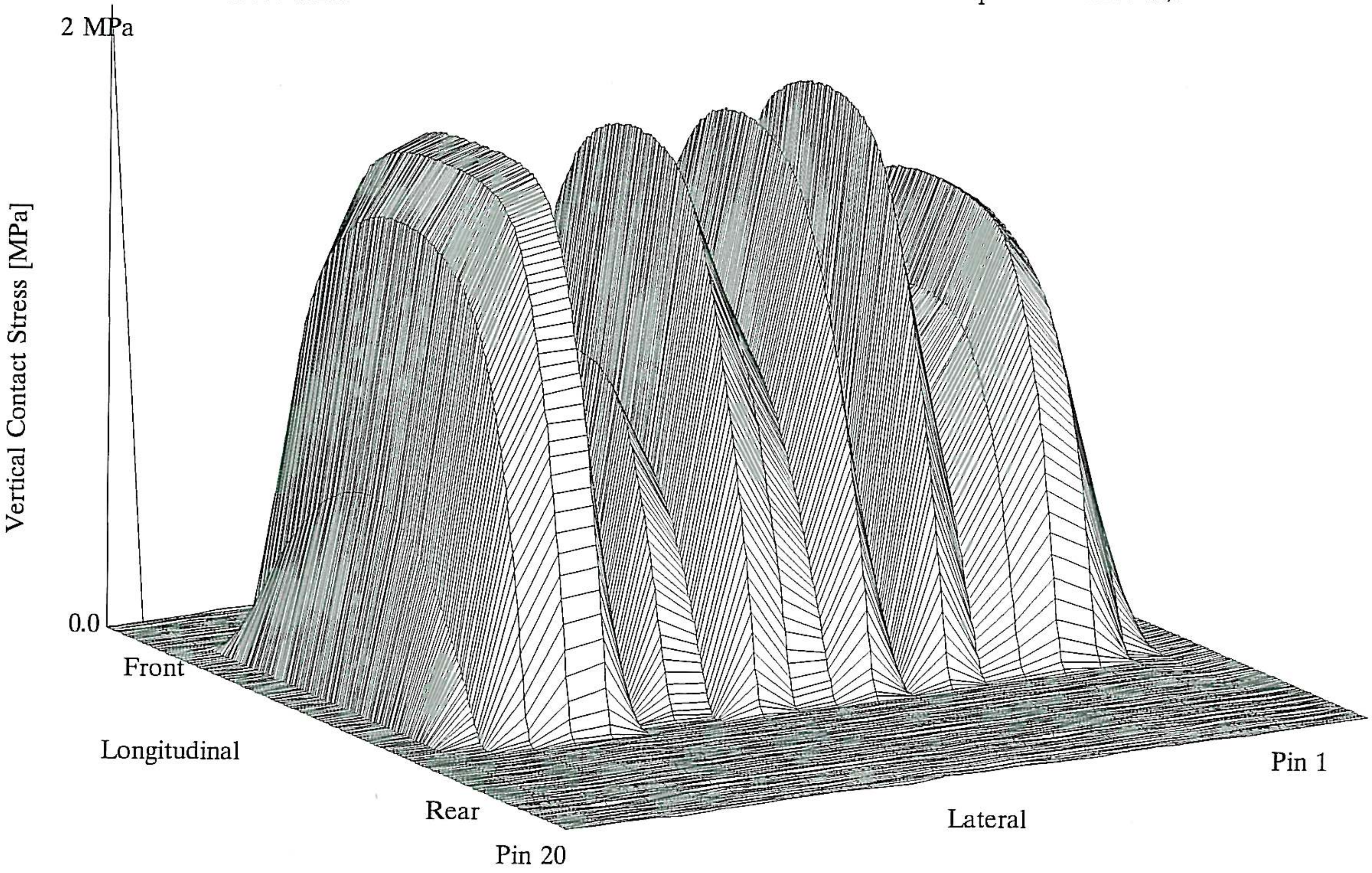
Used Bridgestone 425/65R22.5 R160AZ

Filename : nosc15ax

FIGURE A17X

Applied Vertical Load (HVS) = 75 kN
Measured Vertical Load = 73.6 kN
Max. Stress = 1.766 MPa

Inflation Press. = 1100 kPa
Temperature = 20 deg.C
Wheel Speed = 0.286 m/s



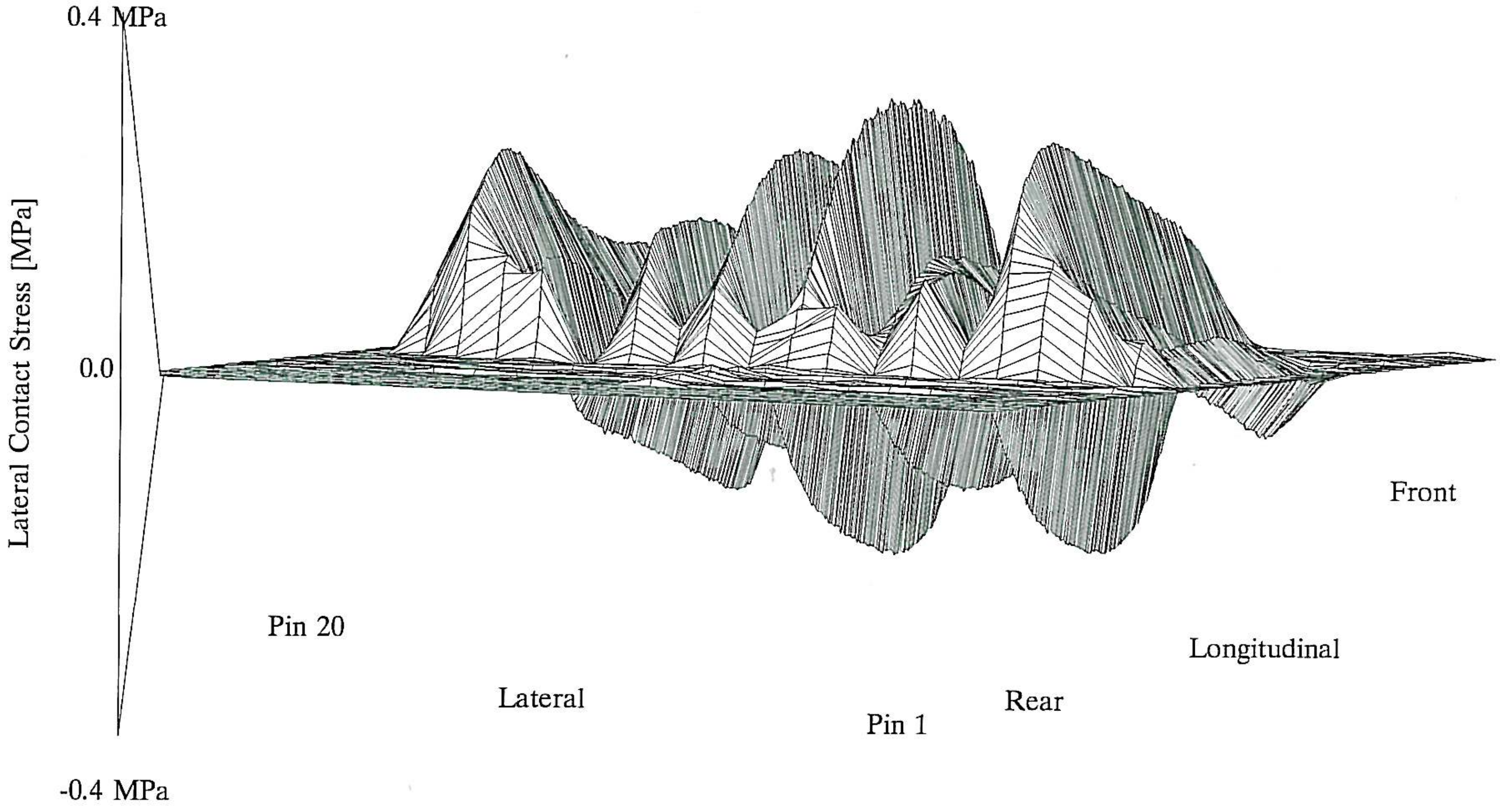
Used Bridgestone 425/65R22.5 R160AZ

FIGURE A18Z

Filename : nosc17az

Applied Vertical Load (HVS) = 75 kN
Measured Lateral Load = 2.701 kN
Max. Stress = 0.2907 MPa
Min. Stress = -0.2221 MPa

Inflation Press. = 1100 kPa
Temperature = 20 deg.C
Wheel Speed = 0.286 m/s



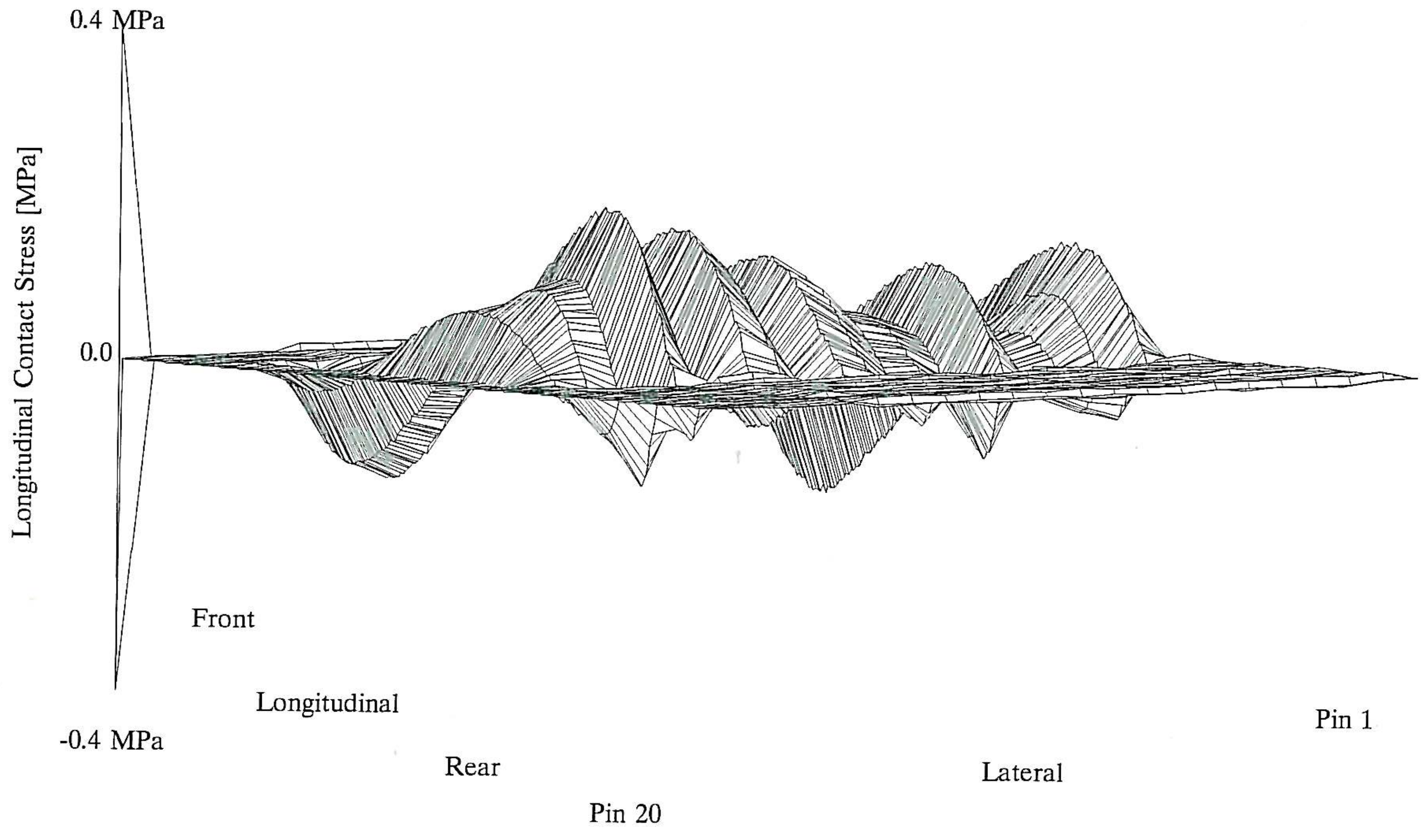
Used Bridgestone 425/65R22.5 R160AZ

FIGURE A18Y

Filename : nosc17ay

Applied Vertical Load (HVS) = 75 kN
Measured Longitudinal Load = 1.285 kN
Max. Stress = 0.2056 MPa
Min. Stress = -0.1728 MPa

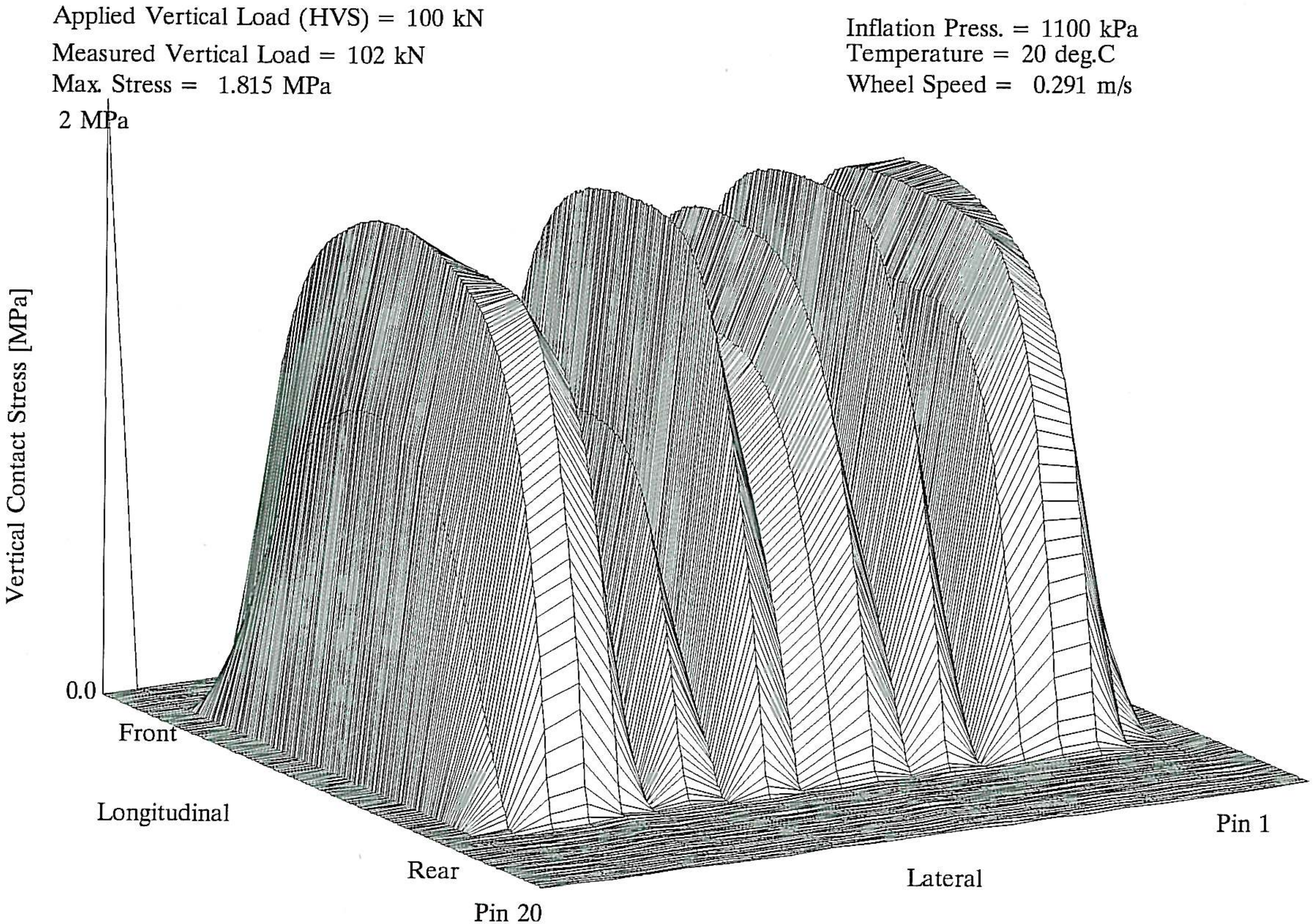
Inflation Press. = 1100 kPa
Temperature = 20 deg.C
Wheel Speed = 0.286 m/s



Used Bridgestone 425/65R22.5 R160AZ

Filename : nosc17ax

FIGURE A18X



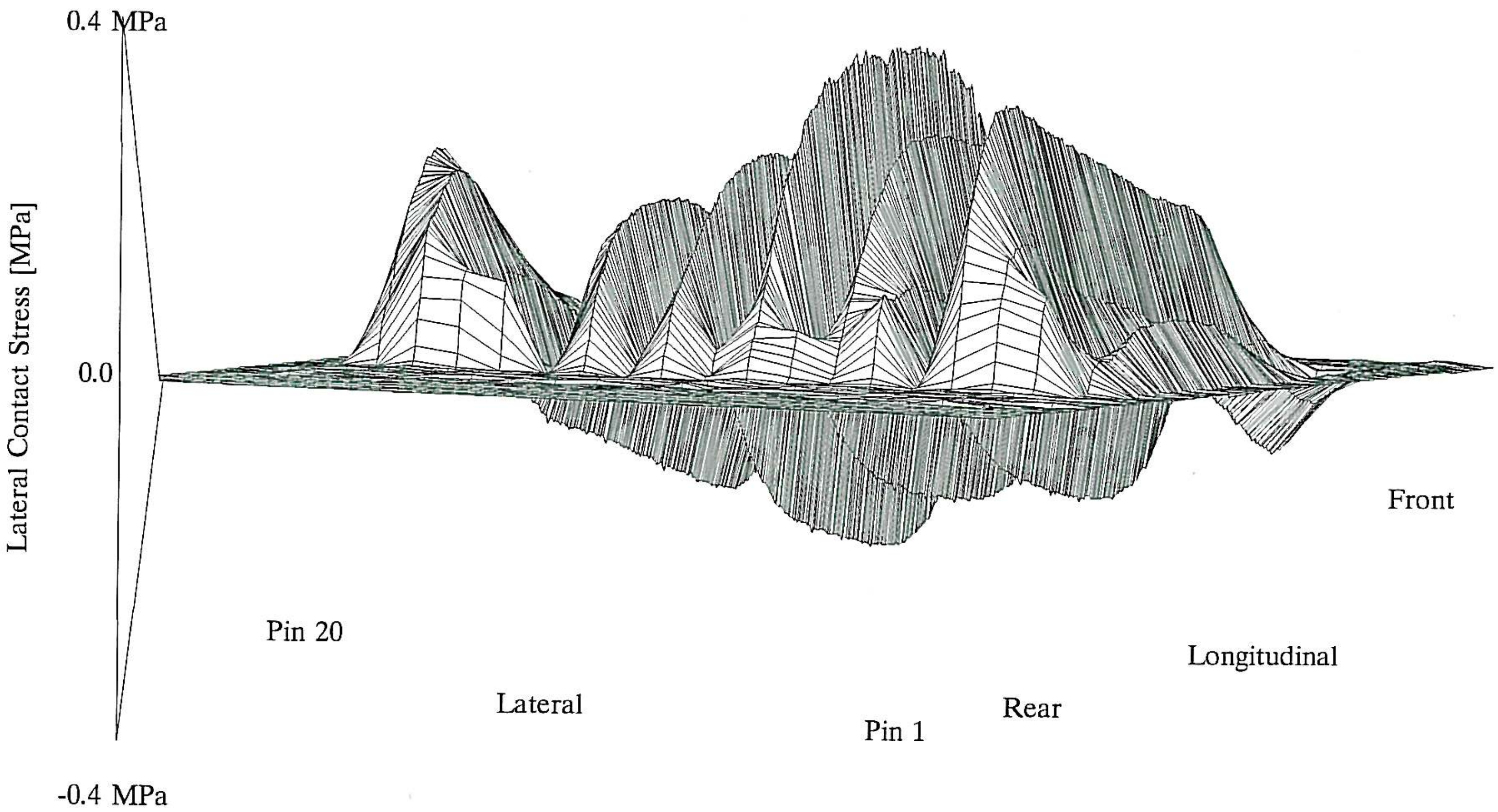
Used Bridgestone 425/65R22.5 R160AZ

FIGURE A19Z

Filename : nosc11az

Applied Vertical Load (HVS) = 100 kN
Measured Lateral Load = 5.328 kN
Max. Stress = 0.3539 MPa
Min. Stress = -0.2052 MPa

Inflation Press. = 1100 kPa
Temperature = 20 deg.C
Wheel Speed = 0.291 m/s



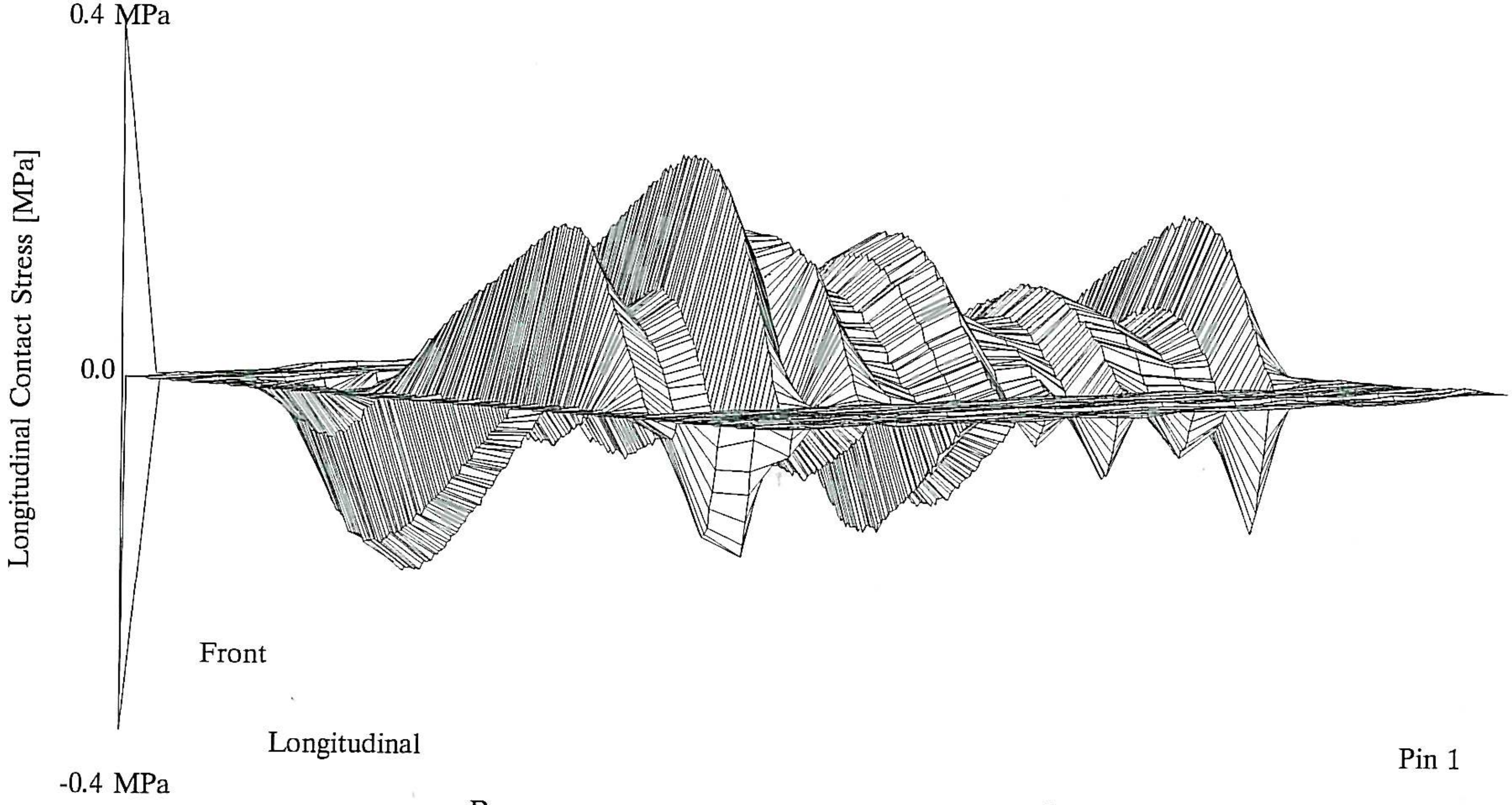
Used Bridgestone 425/65R22.5 R160AZ

FIGURE A19Y

Filename : noscl1ay

Applied Vertical Load (HVS) = 100 kN
Measured Longitudinal Load = 1.68 kN
Max. Stress = 0.2774 MPa
Min. Stress = -0.2153 MPa

Inflation Press. = 1100 kPa
Temperature = 20 deg.C
Wheel Speed = 0.291 m/s



Used Bridgestone 425/65R22.5 R160AZ

Filename : noscl1ax

FIGURE A19X

APPENDIX B:

3-DIMENSIONAL (3-D) PLOTS OF STRESSES MEASURED UNDER THE LINTRACK *USED* BRIDGESTONE 425/65 R 22.5 R160AZ TYRE AT "TRAFFIC SPEED"

TABLE 1 (Cont.): HVS4: 3D Stress Sensor Tests on the used(old) Bridgestone R160AZ 425/65 R22.5 PR20 tyre

Legend of filename with tests on OLD (used) tyre : NOSC92AZ.PRN : **TRAFFIC TESTS**

N=Netherlands ; O=Lintrack (Old or used tyre) ; S=Super single ; C=Creep speed;(or T=Traffic (HVS) speed) ;

9=Cold inflation pressure 950 kPa ; 2=Vertical load 25 kN : A=Test (repeat)1 (or B=repeat 2 or C=repeat 3);

Z=Vertical stress (or X=Transverse, or Y=Longitudinal).

DATE 10/06/96

Speed Sensor distance = 1.0m

NETOLD.WK1

HVS POSITION

Traffic side

Traffic side | Cabin end

Caravan side

Filename		PRESSURE	HVS	LOAD BOX	TEMP	SPEED	Hz	Figure	Pin numbers across loadcell										A = ALL DIRECTIONS MISSED THE PIN										3d-Loadcell
*.prn		(kPa)	(kN)	(kN)	°C	(m/s)	(sam/sec)	no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total load (kN)
NOST52	Az/x/y	500	25	24.2	21	3.617	1500	B1	A																		A	A	23.15
NOST52	Bz/x/y	500	25	24.2	21	3.701	1500	-	A																		A	A	22.74
NOST52	Cz/x/y	500	25	24.2	21	3.660	1500	-	A																		A	A	24.22
NOST55	Az/x/y	500	50	49.7	21	3.646	1500	B2	A				A														A	A	45.05
NOST55	Bz/x/y	500	50	49.8	21	3.661	1500	-	A				A														A	A	44.27
NOST55	Cz/x/y	500	50	49.8	21	3.704	1500	-	A				A														A	A	45.15
NOST57	Az/x/y	500	75	73.7	21	2.518	1000	B3	A																			A	78.81
NOST57	Bz/x/y	500	75	73.7	21	3.699	1000	-	A														A					A	71.89
NOST57	Cz/x/y	500	75	73.7	21	3.707	1000	-	A														A					A	70.83
NOST72	Az/x/y	700	25	23.2	20	4.524	1000	B4	A	A																	A	A	22.50
NOST72	Bz/x/y	700	25	23.2	20	4.168	1500	-	A	A																	A	A	23.46
NOST72	Cz/x/y	700	25	23.2	20	4.252	1500	-	A	A																	A	A	22.81
NOST75	Az/x/y	700	50	48.6	20	3.626	1500	B5	A																			A	49.11
NOST75	Bz/x/y	700	50	48.6	20	3.715	1500	-	A																			A	46.68
NOST75	Cz/x/y	700	50	48.6	20	3.765	1500	-	A																			A	45.19
NOST77	Az/x/y	700	75	74.1	21	3.745	1500	B6	A																			A	73.39
NOST77	Bz/x/y	700	75	74.0	21	3.717	1500	-	A																			A	74.24
NOST77	Cz/x/y	700	75	74.0	21	4.044	1500	-	A																			A	75.94
NOST71	Az/x/y	700	100	100.1	21	3.765	1000	B7	A																			A	100.16
NOST71	Bz/x/y	700	100	99.9	21	4.074	1000	-	A																			A	101.40
NOST71	Cz/x/y	700	100	99.9	21	3.860	1000	-	A																			A	102.02
NOT902	Az/x/y	900	25	23.4	25	2.973	1500	B8	A	A																	A	A	23.64
NOT902	Bz/x/y	900	25	23.4	25	2.943	1500	-	A	A																	A	A	23.43
NOT902	Cz/x/y	900	25	23.4	25	2.836	1500	-	A	A																	A	A	22.45
NOT905	Az/x/y	900	50	48.5	25	2.834	1500	-	A																			A	45.22
NOT905	Bz/x/y	900	50	48.8	25	2.856	1500	-	A																			A	45.25
NOT905	Cz/x/y	900	50	48.8	25	2.831	1500	B9	A																			A	45.11
NOT907	Az/x/y	900	75	74.5	24	2.980	1500	B10	A																			A	71.33
NOT907	Bz/x/y	900	75	74.3	24	2.911	1500	-	A																			A	72.08
NOT907	Cz/x/y	900	75	73.7	24	2.972	1500	-	A																			A	74.51

TABLE 1 (Cont.): HVS4: 3D Stress Sensor Tests on the used(old) Bridgestone R160AZ 425/65 R22.5 PR20 tyre

Legend of filename with tests on OLD (used) tyre : NOSC92AZ.PRN : **TRAFFIC TESTS**

N=Netherlands ; O=Lintrack (Old or used tyre) ; S=Super single ; C=Creep speed;(or T=Traffic (HVS) speed) ;

9=Cold inflation pressure 950 kPa ; 2=Vertical load 25 kN : A=Test (repeat)1 (or B=repeat 2 or C=repeat 3);

Z=Vertical stress (or X=Transverse, or Y=Longitudinal).

DATE 10/06/96

Speed Sensor distance = 1.0m

NETOLD.WK1

HVS POSITION

Traffic side

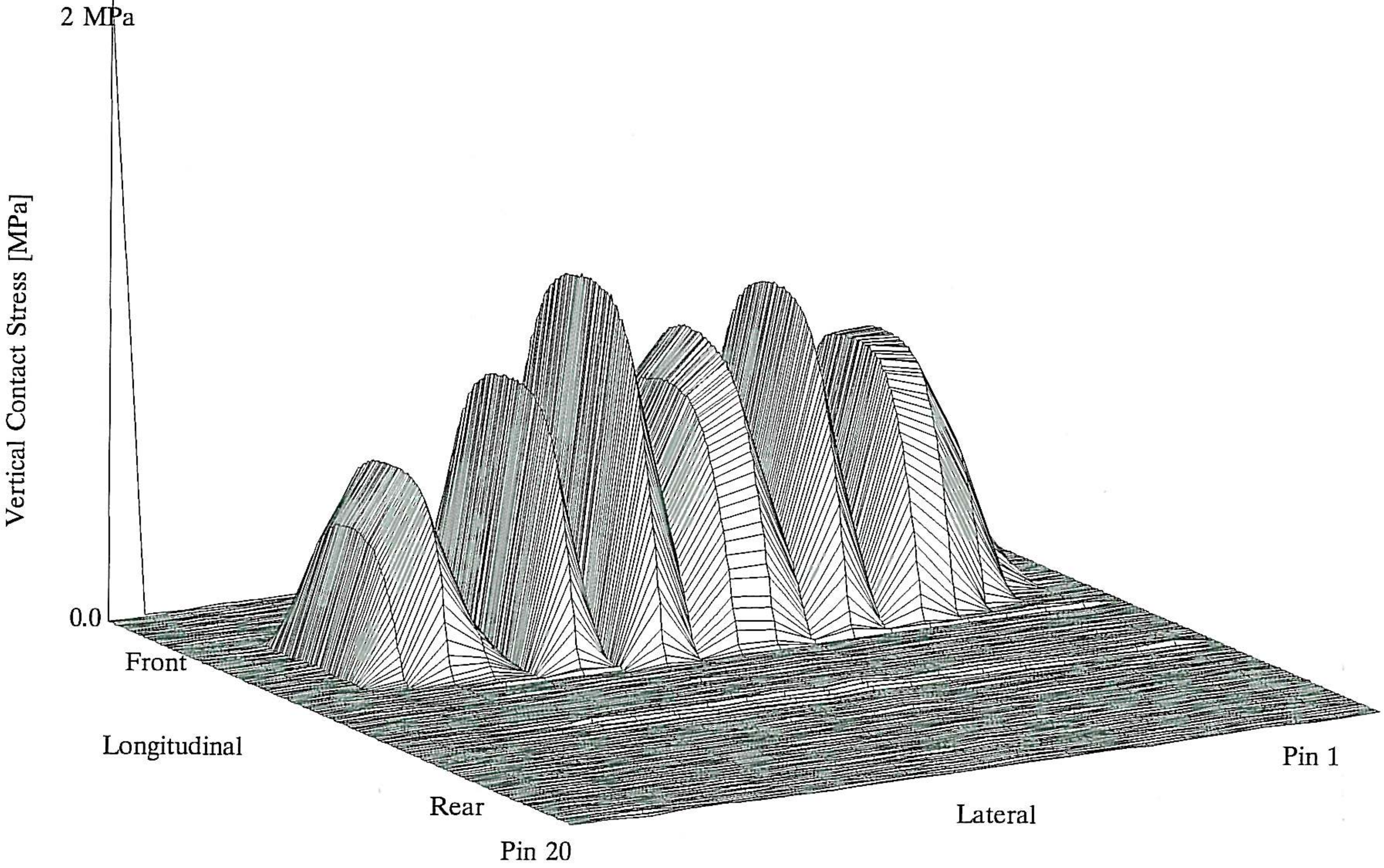
Traffic side | Cabin end

Caravan side

Filename *.prn		PRESSURE (kPa)	HVS (kN)	LOAD BOX (kN)	TEMP °C	SPEED (m/s)	Hz (sam/sec)	Figure no.	Pin numbers across loadcell A = ALL DIRECTIONS MISSED THE PIN 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	3d-Loadcell Total load (kN)
NOT901	Az/x/y	900	100	100.6	24	2.807	1000	B11	A																			A	103.47
NOT901	Bz/x/y	900	100	100.6	24	2.808	1000	-	A																			A	105.30
NOT901	Cz/x/y	900	100	99.6	24	2.834	1000	-	A																			A	106.00
NOST92	Az/x/y	950	25	24.3	22	2.803	1000	B12	A																	A	A	A	25.40
NOST92	Bz/x/y	950	25	24.3	22	2.747	1500	-	A																	A	A	A	24.25
NOST92	Cz/x/y	950	25	24.3	22	2.619	1500	-	A																	A	A	A	23.10
NOST95	Az/x/y	950	50	48.8	22	2.618	1500	B13	A																			A	54.37
NOST95	Bz/x/y	950	50	48.9	22	2.728	1500	-	A																			A	50.11
NOST95	Cz/x/y	950	50	48.8	22	2.866	1500	-	A																			A	50.16
NOST97	Az/x/y	950	75	73.8	22	2.997	1500	B14	A																			A	76.07
NOST97	Bz/x/y	950	75	73.7	22	3.035	1500	-	A																			A	77.70
NOST97	Cz/x/y	950	75	73.7	22	2.988	1500	-	A																			A	73.93
NOST91	Az/x/y	950	100	99.8	22	2.777	1000	B15	A																			A	102.96
NOST91	Bz/x/y	950	100	99.8	22	2.748	1000	-	A																			A	101.24
NOST91	Cz/x/y	950	100	100.1	22	2.754	1000	-	A																			A	103.17
NOST12	Az/x/y	1100	25	25.1	20	3.321	1500	B16	A	A																	A	A	23.91
NOST12	Bz/x/y	1100	25	25.4	20	3.508	1500	-	A	A																	A	A	24.33
NOST12	Cz/x/y	1100	25	25.4	20	3.287	1500	-	A	A																	A	A	25.48
NOST15	Az/x/y	1100	50	48.8	20	3.009	1500	B17	A																			A	48.78
NOST15	Bz/x/y	1100	50	48.8	20	3.029	1500	-	A																			A	47.57
NOST15	Cz/x/y	1100	50	48.8	20	2.618	1500	-	A																			A	47.14
NOST17	Az/x/y	1100	75	74.2	21	2.967	1000	B18	A																			A	78.54
NOST17	Bz/x/y	1100	75	74.1	21	3.196	1000	-	A																			A	80.63
NOST17	Cz/x/y	1100	75	74.5	21	3.094	1000	-	A																			A	82.07
NOST11	Az/x/y	1100	100	100.1	22	3.175	1000	B19	A																			A	104.19
NOST11	Bz/x/y	1100	100	100.4	22	2.993	1000	-	A																			A	111.58
NOST11	Cz/x/y	1100	100	100.1	22	3.211	1000	-	A																			A	110.11

Applied Vertical Load (HVS) = 25 kN
Measured Vertical Load = 23.19 kN
Max. Stress = 1.138 MPa

Inflation Press. = 500 kPa
Temperature = 21 deg.C
Wheel Speed = 3.617 m/s



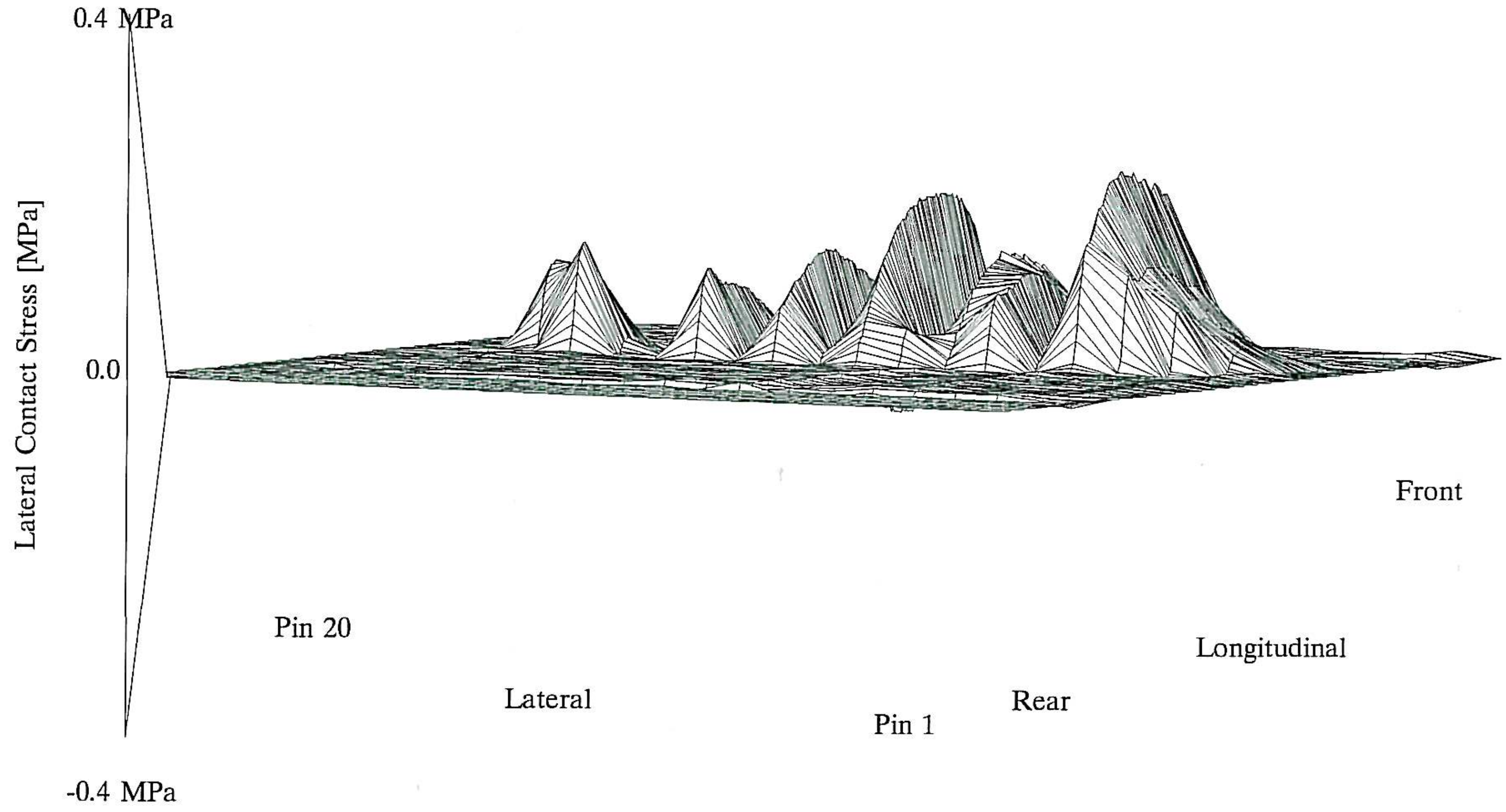
Used Bridgestone 425/65R22.5 R160AZ

FIGURE B1Z

Filename : nost52az

Applied Vertical Load (HVS) = 25 kN
Measured Lateral Load = 2.127 kN
Max. Stress = 0.218 MPa
Min. Stress = -0.06177 MPa

Inflation Press. = 500 kPa
Temperature = 21 deg.C
Wheel Speed = 3.617 m/s



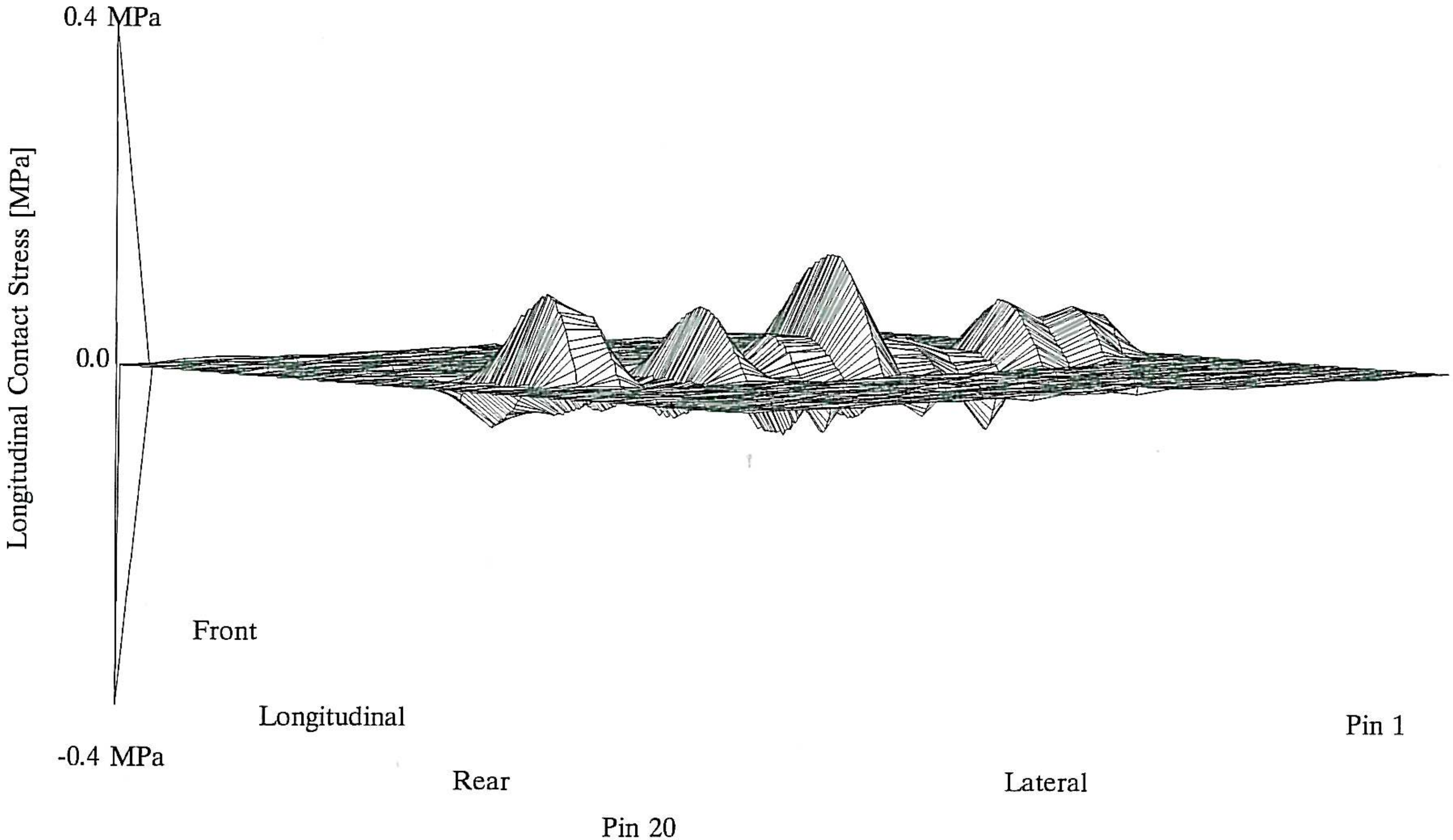
Filename : nost52ay

Used Bridgestone 425/65R22.5 R160AZ

FIGURE B1Y

Applied Vertical Load (HVS) = 25 kN
Measured Longitudinal Load = 0.2361 kN
Max. Stress = 0.1382 MPa
Min. Stress = -0.08299 MPa

Inflation Press. = 500 kPa
Temperature = 21 deg.C
Wheel Speed = 3.617 m/s



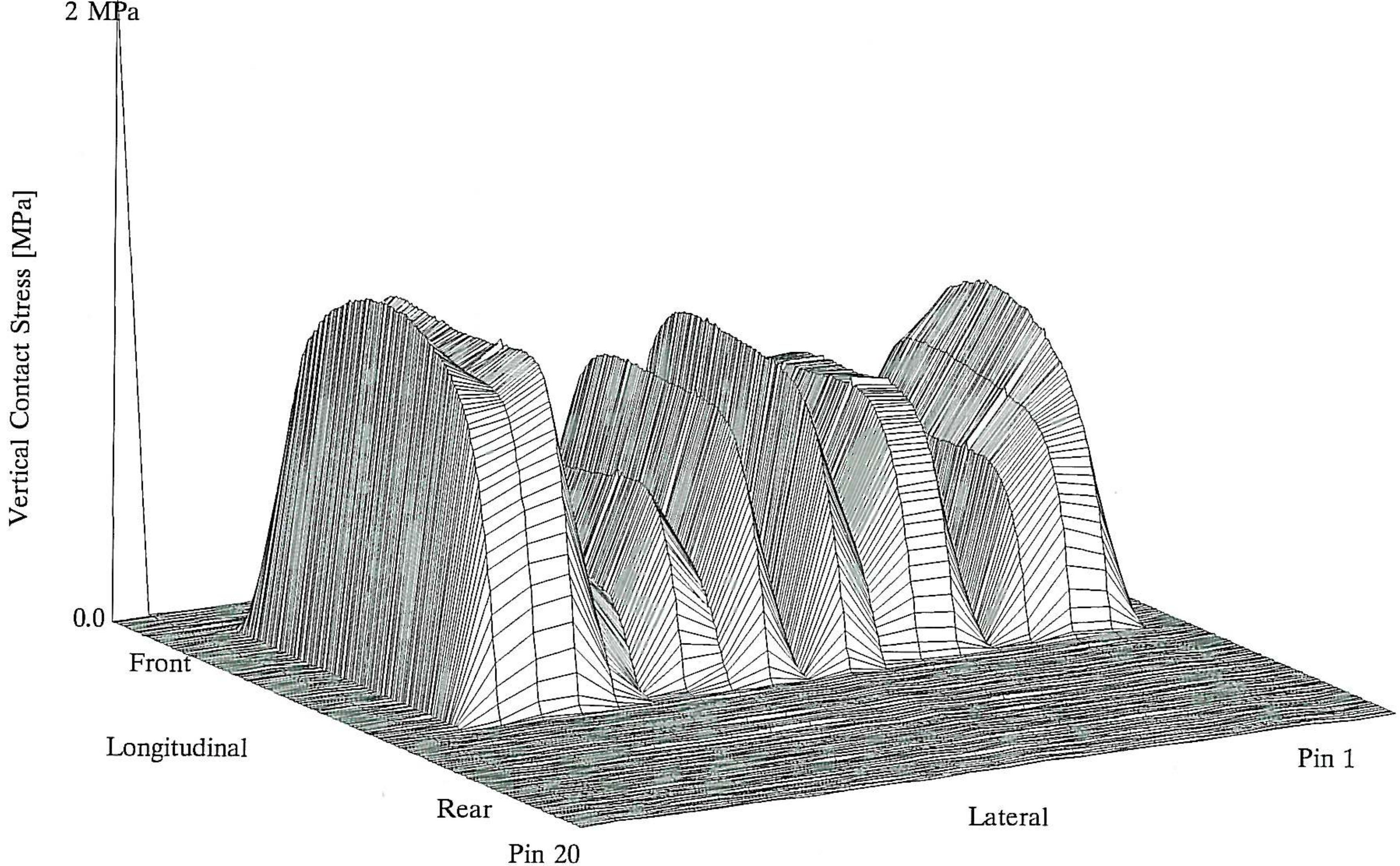
Used Bridgestone 425/65R22.5 R160AZ

Filename : nost52ax

FIGURE B1X

Applied Vertical Load (HVS) = 50 kN
Measured Vertical Load = 45.17 kN
Max. Stress = 1.173 MPa

Inflation Press. = 500 kPa
Temperature = 21 deg.C
Wheel Speed = 3.646 m/s



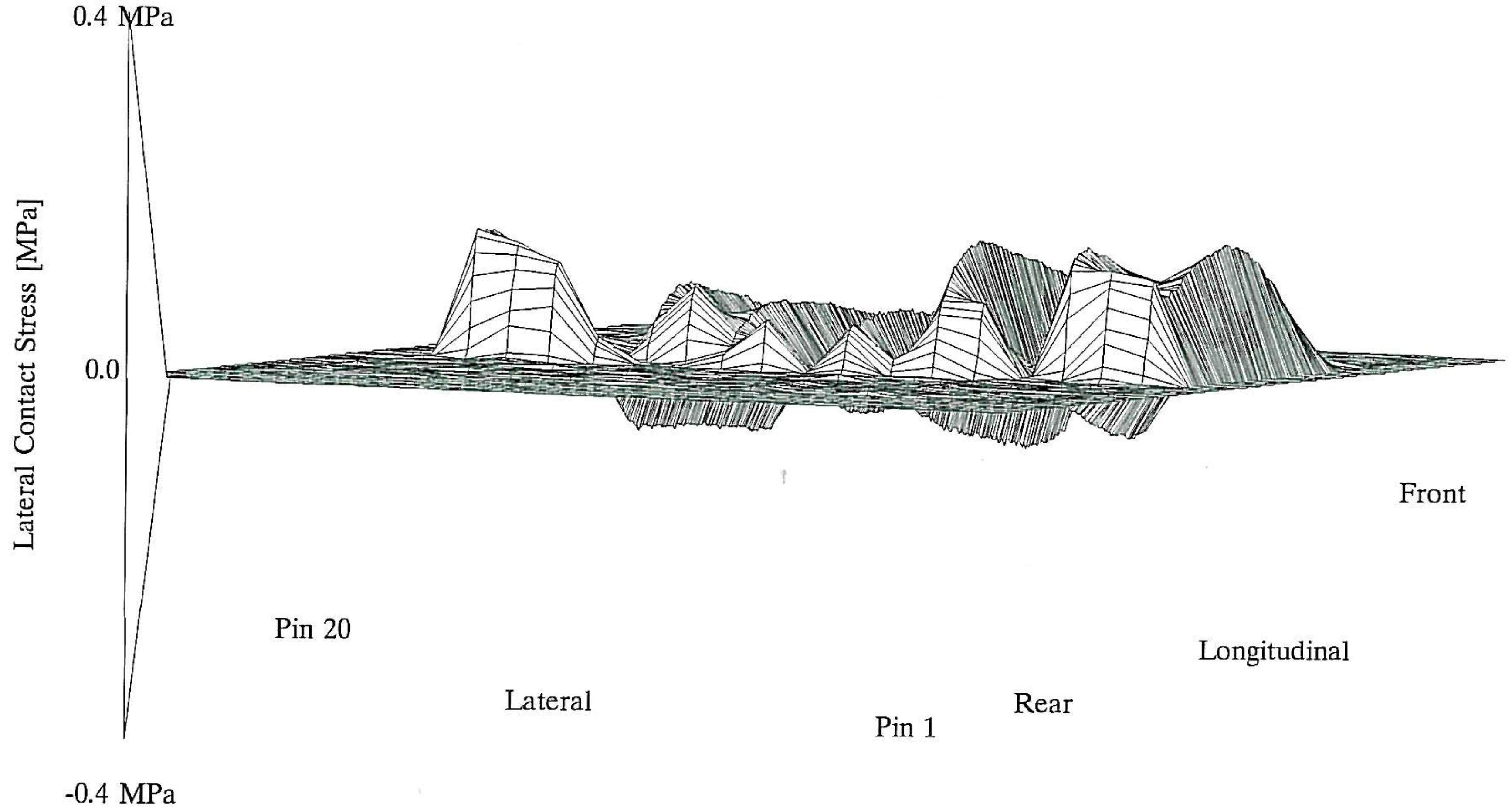
Used Bridgestone 425/65R22.5 R160AZ

FIGURE B2Z

Filename : nost55az

Applied Vertical Load (HVS) = 50 kN
Measured Lateral Load = 1.373 kN
Max. Stress = 0.1471 MPa
Min. Stress = -0.09493 MPa

Inflation Press. = 500 kPa
Temperature = 21 deg.C
Wheel Speed = 3.646 m/s



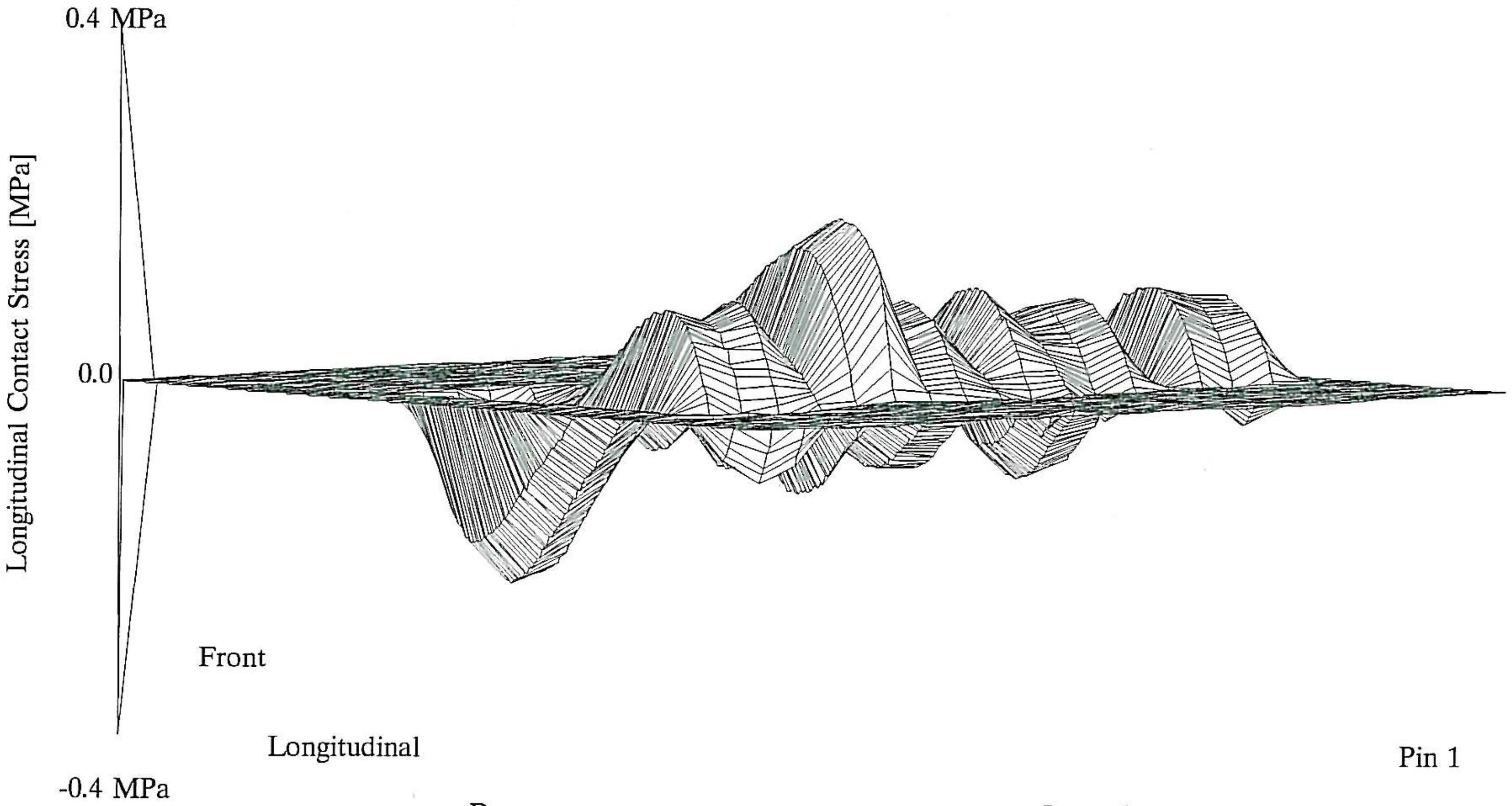
Used Bridgestone 425/65R22.5 R160AZ

Filename : nost55ay

FIGURE B2Y

Applied Vertical Load (HVS) = 50 kN
Measured Longitudinal Load = 0.285 kN
Max. Stress = 0.204 MPa
Min. Stress = -0.216 MPa

Inflation Press. = 500 kPa
Temperature = 21 deg.C
Wheel Speed = 3.646 m/s



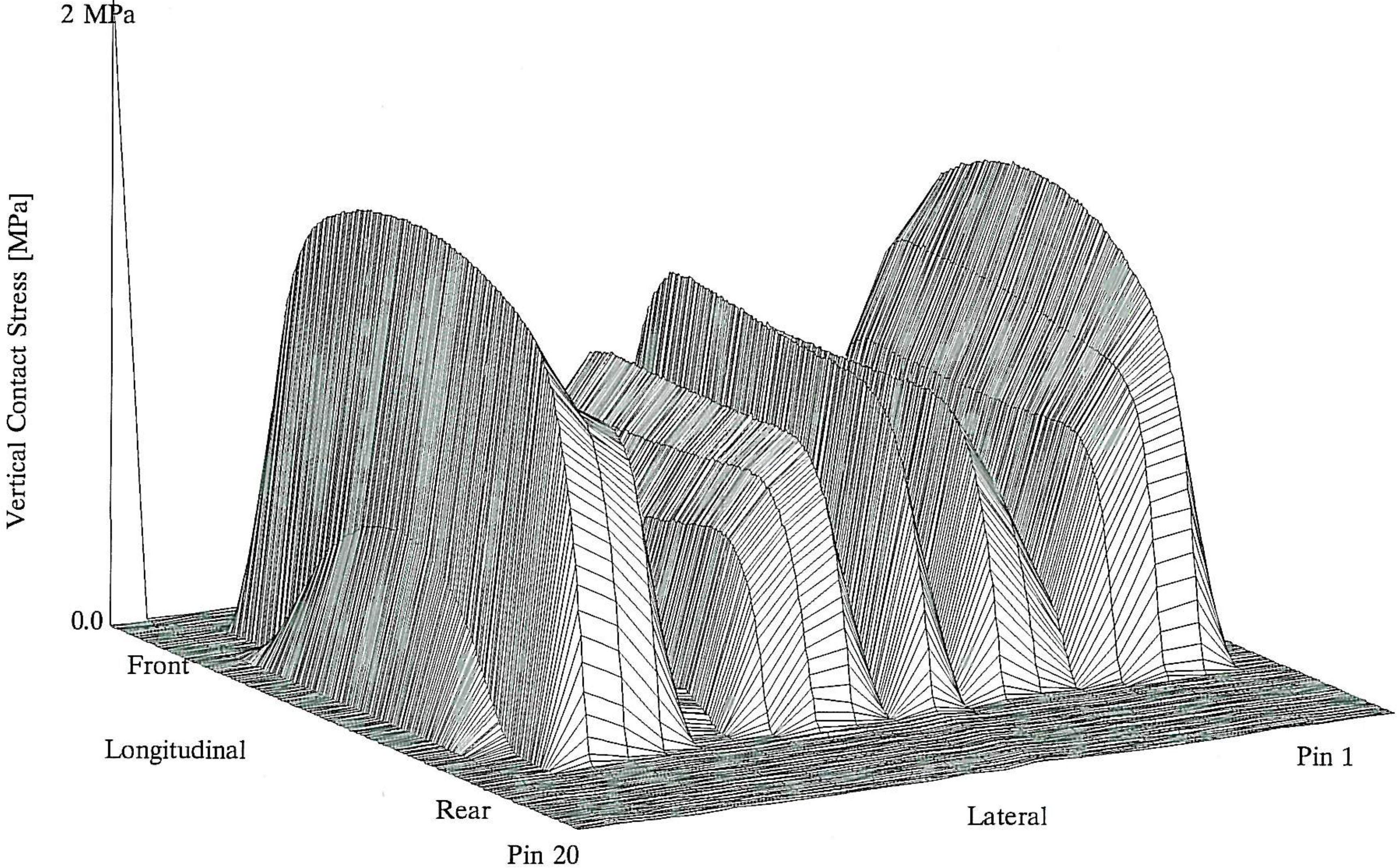
Used Bridgestone 425/65R22.5 R160AZ

Filename : nost55ax

FIGURE B2X

Applied Vertical Load (HVS) = 75 kN
Measured Vertical Load = 78.95 kN
Max. Stress = 1.47 MPa

Inflation Press. = 500 kPa
Temperature = 21 deg.C
Wheel Speed = 2.518 m/s



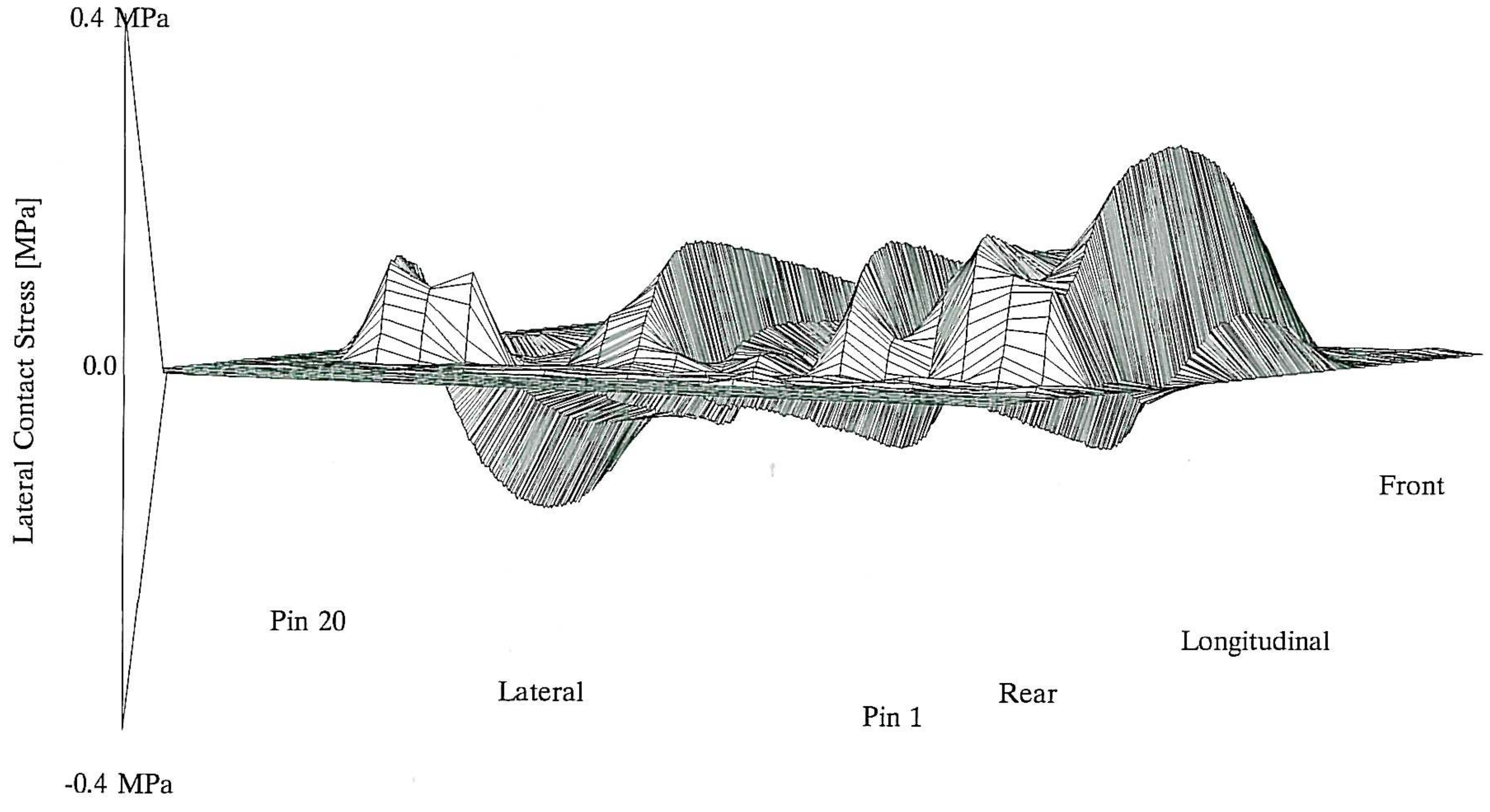
Used Bridgestone 425/65R22.5 R160AZ

Filename : nost57az

FIGURE B3Z

Applied Vertical Load (HVS) = 75 kN
Measured Lateral Load = 2.923 kN
Max. Stress = 0.2555 MPa
Min. Stress = -0.1836 MPa

Inflation Press. = 500 kPa
Temperature = 21 deg.C
Wheel Speed = 2.518 m/s



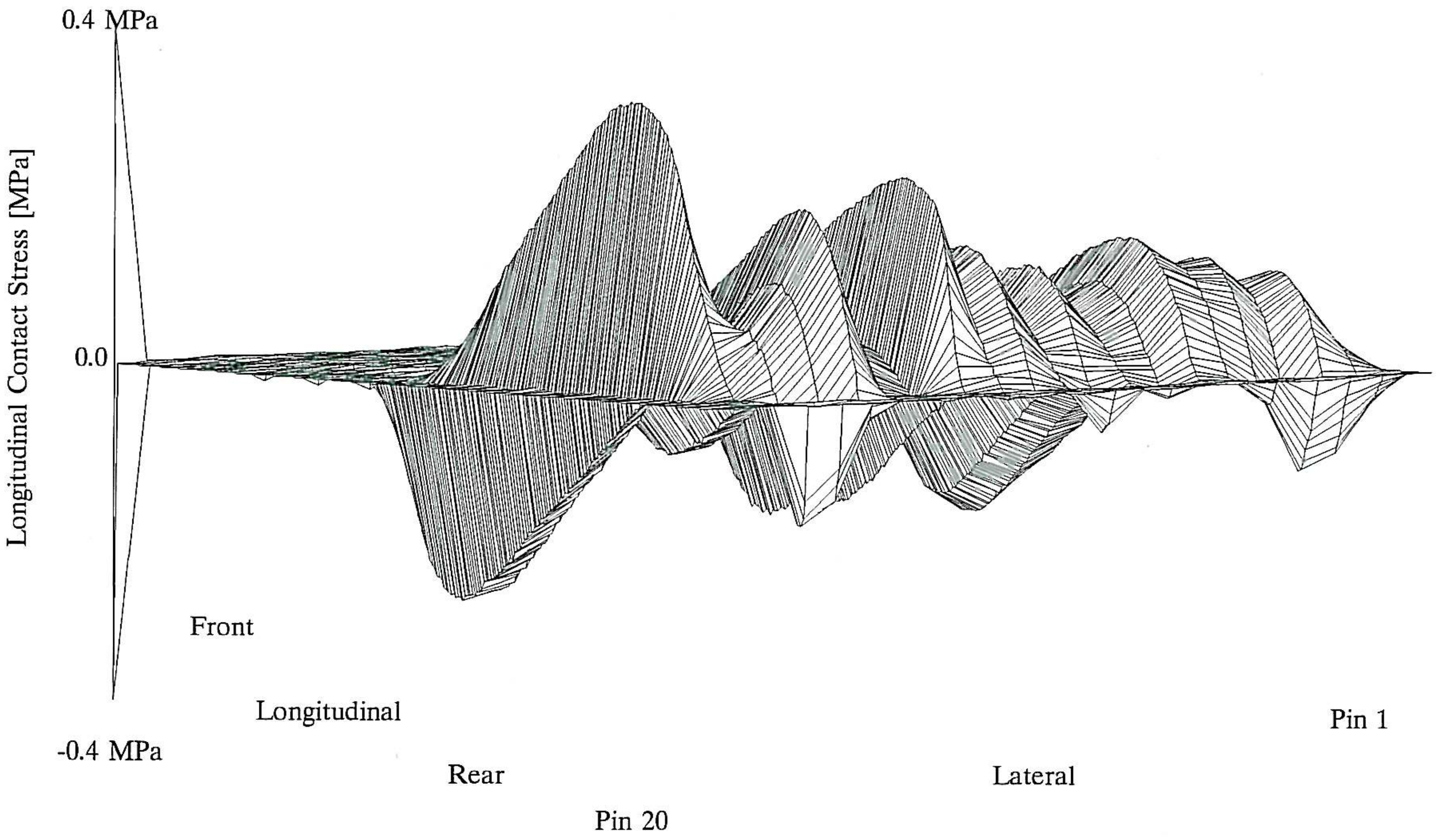
Used Bridgestone 425/65R22.5 R160AZ

FIGURE B3Y

Filename : nost57ay

Applied Vertical Load (HVS) = 75 kN
Measured Longitudinal Load = 1.863 kN
Max. Stress = 0.348 MPa
Min. Stress = -0.2669 MPa

Inflation Press. = 500 kPa
Temperature = 21 deg.C
Wheel Speed = 2.518 m/s



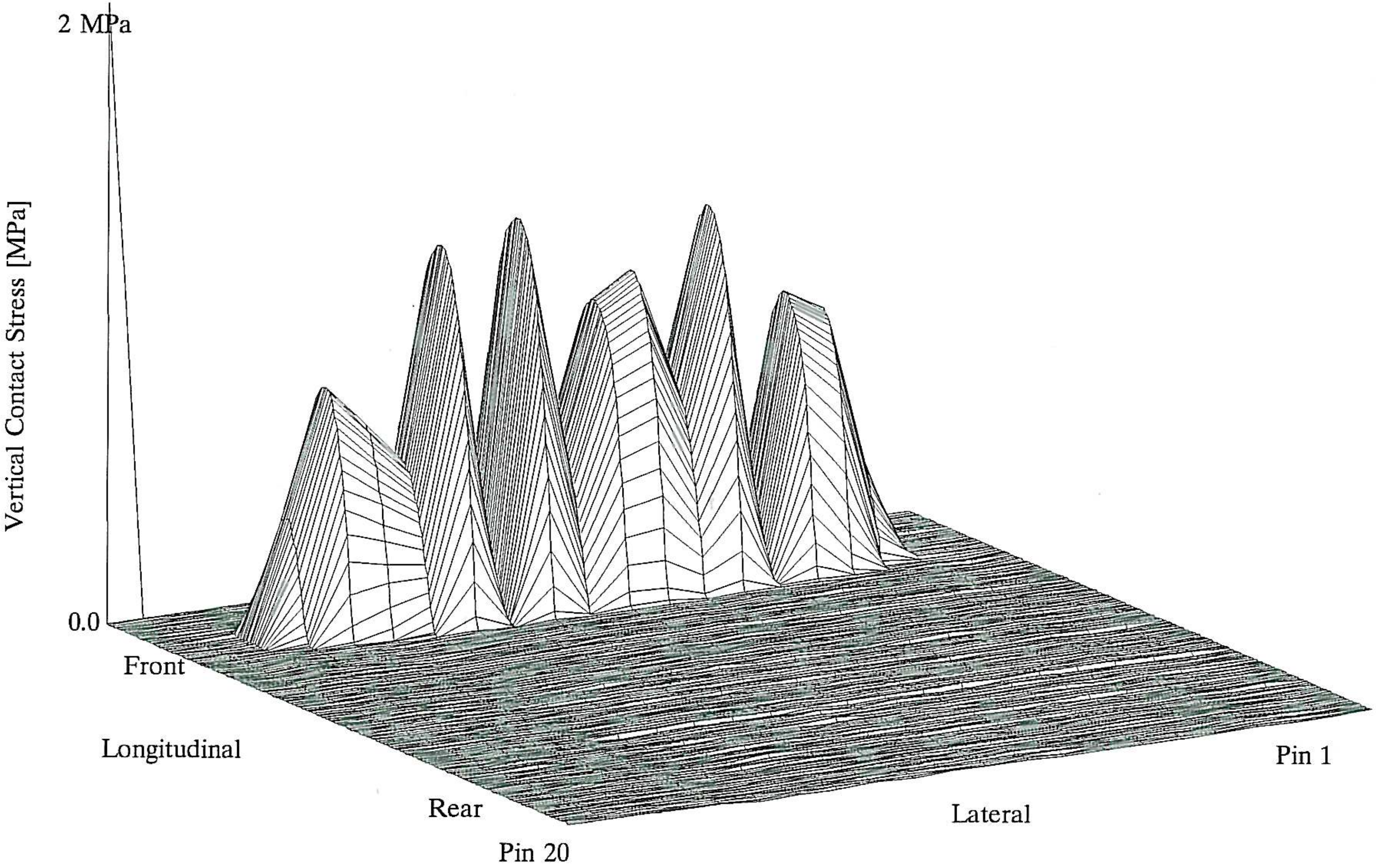
Used Bridgestone 425/65R22.5 R160AZ

Filename : nost57ax

FIGURE B3X

Applied Vertical Load (HVS) = 25 kN
Measured Vertical Load = 21.87 kN
Max. Stress = 1.246 MPa

Inflation Press. = 700 kPa
Temperature = 20 deg.C
Wheel Speed = 4.524 m/s



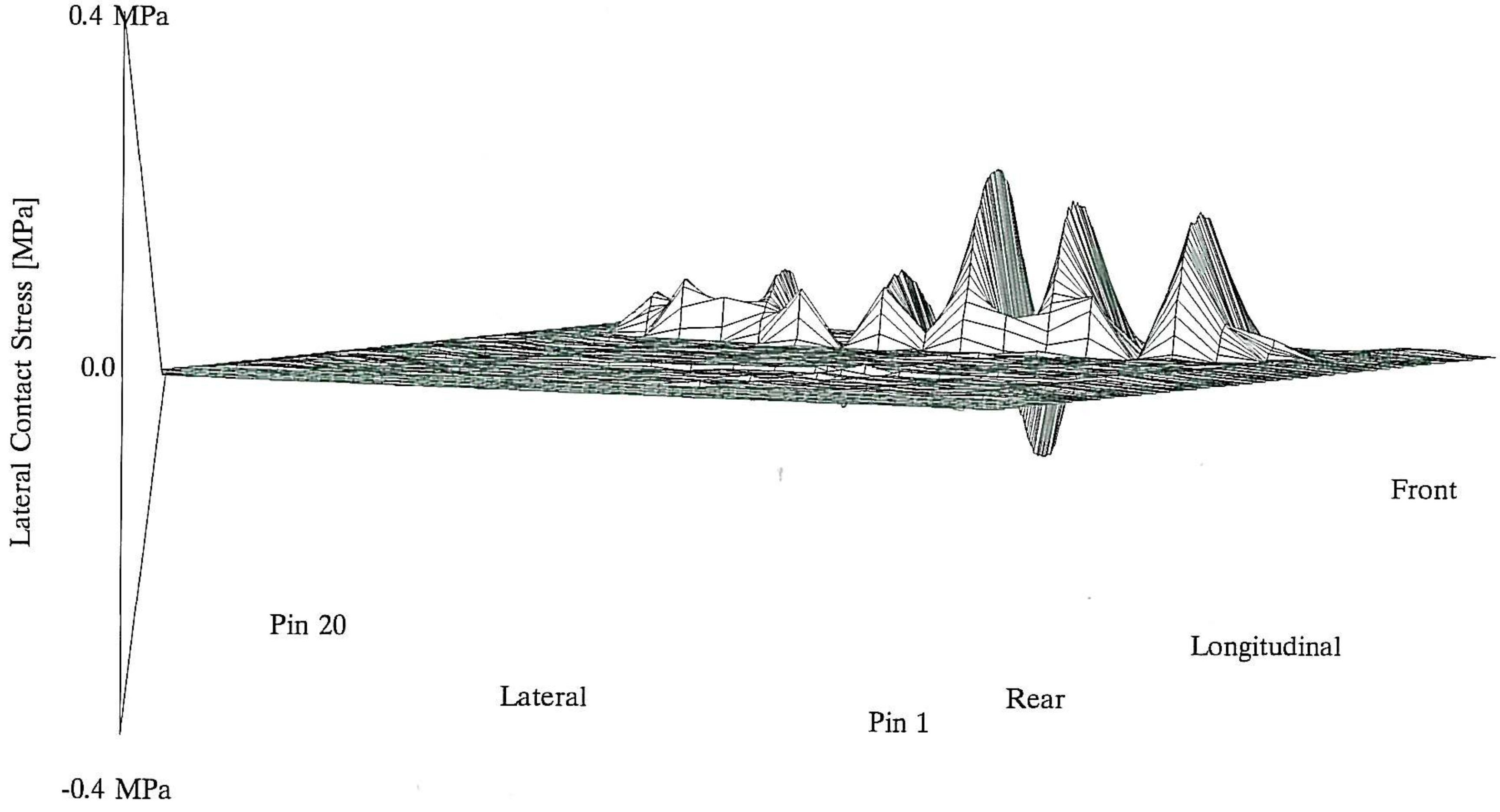
Used Bridgestone 425/65R22.5 R160AZ

Filename : nost72az

FIGURE B4Z

Applied Vertical Load (HVS) = 25 kN
Measured Lateral Load = 1.273 kN
Max. Stress = 0.1984 MPa
Min. Stress = -0.1193 MPa

Inflation Press. = 700 kPa
Temperature = 20 deg.C
Wheel Speed = 4.524 m/s



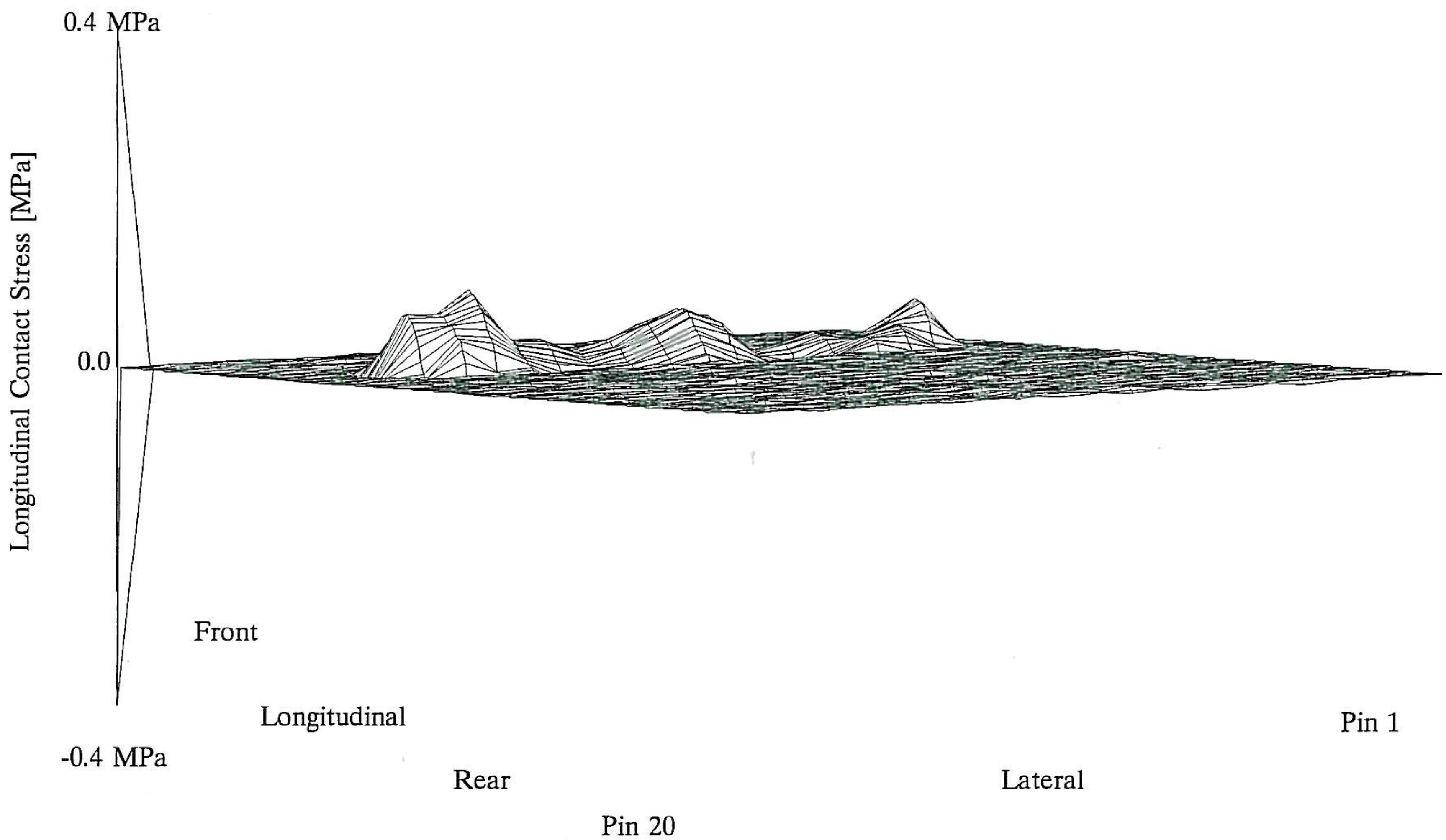
Used Bridgestone 425/65R22.5 R160AZ

FIGURE B4Y

Filename : nost72ay

Applied Vertical Load (HVS) = 25 kN
Measured Longitudinal Load = 0.7036 kN
Max. Stress = 0.09741 MPa
Min. Stress = -0.04251 MPa

Inflation Press. = 700 kPa
Temperature = 20 deg.C
Wheel Speed = 4.524 m/s



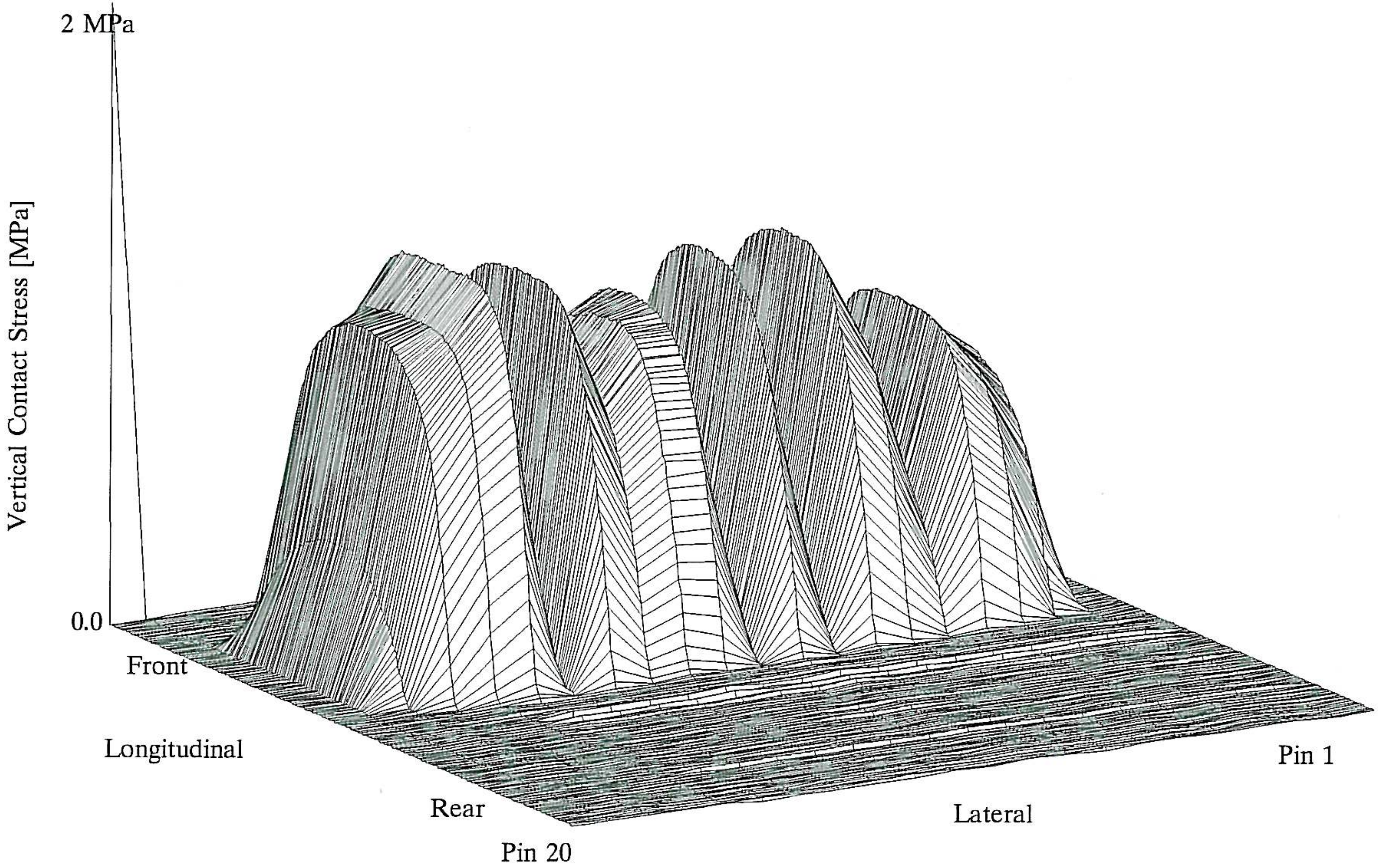
Used Bridgestone 425/65R22.5 R160AZ

Filename : nost72ax

FIGURE B4X

Applied Vertical Load (HVS) = 50 kN
Measured Vertical Load = 49.07 kN
Max. Stress = 1.273 MPa

Inflation Press. = 700 kPa
Temperature = 20 deg.C
Wheel Speed = 3.626 m/s



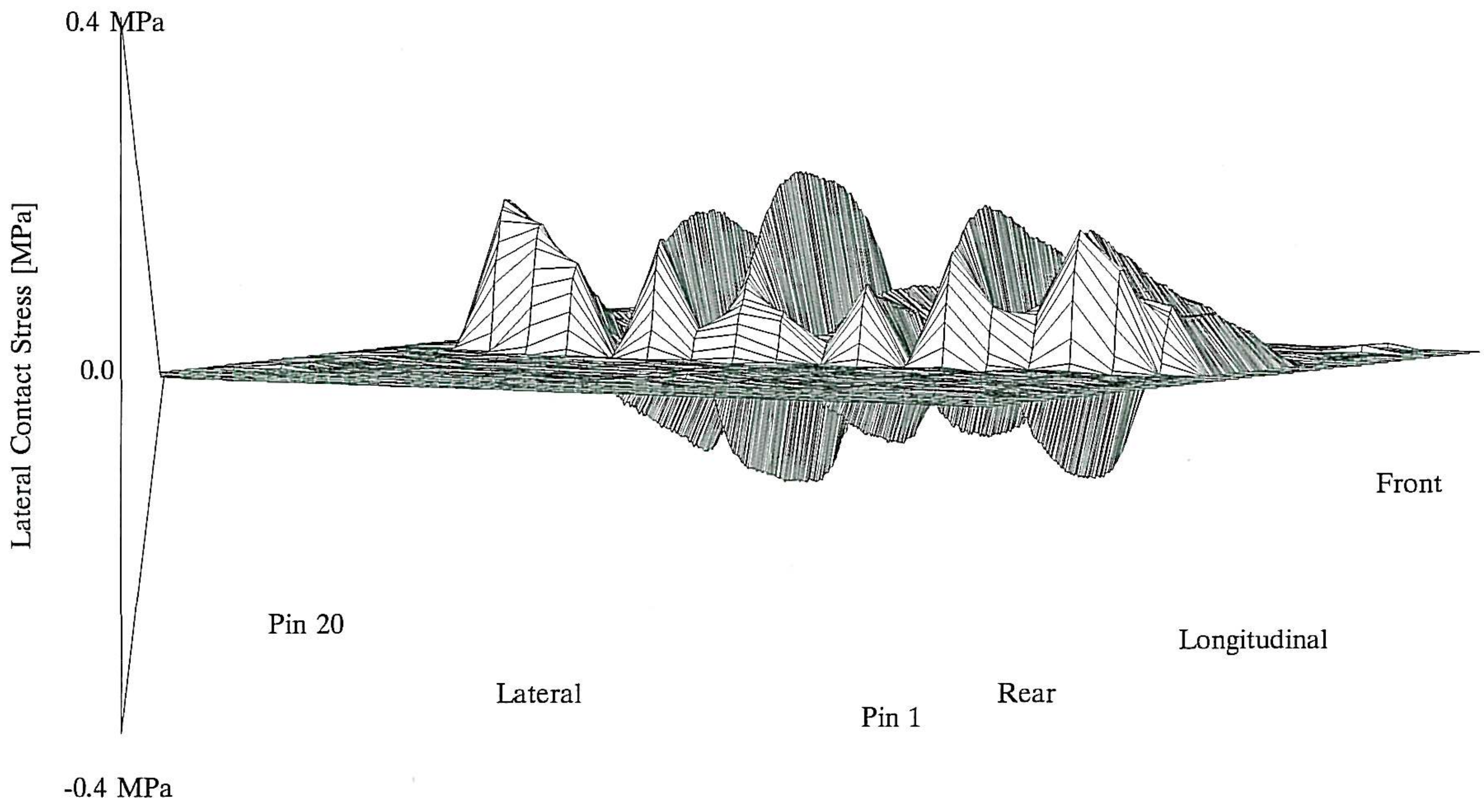
Used Bridgestone 425/65R22.5 R160AZ

FIGURE B5Z

Filename : nost75az

Applied Vertical Load (HVS) = 50 kN
Measured Lateral Load = 2.349 kN
Max. Stress = 0.2051 MPa
Min. Stress = -0.1505 MPa

Inflation Press. = 700 kPa
Temperature = 20 deg.C
Wheel Speed = 3.626 m/s



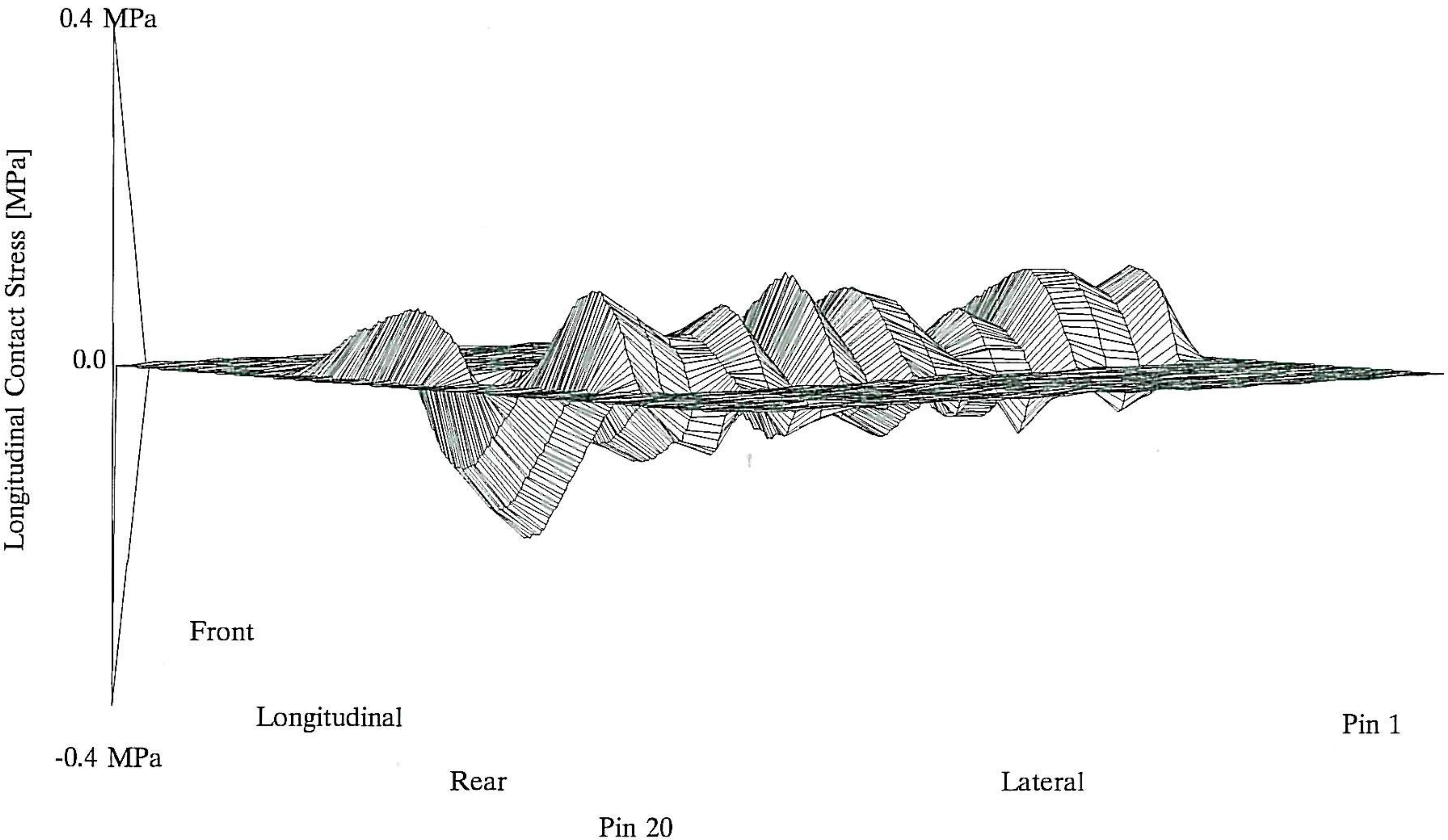
Used Bridgestone 425/65R22.5 R160AZ

FIGURE B5Y

Filename : nost75ay

Applied Vertical Load (HVS) = 50 kN
Measured Longitudinal Load = 0.1048 kN
Max. Stress = 0.1236 MPa
Min. Stress = -0.1933 MPa

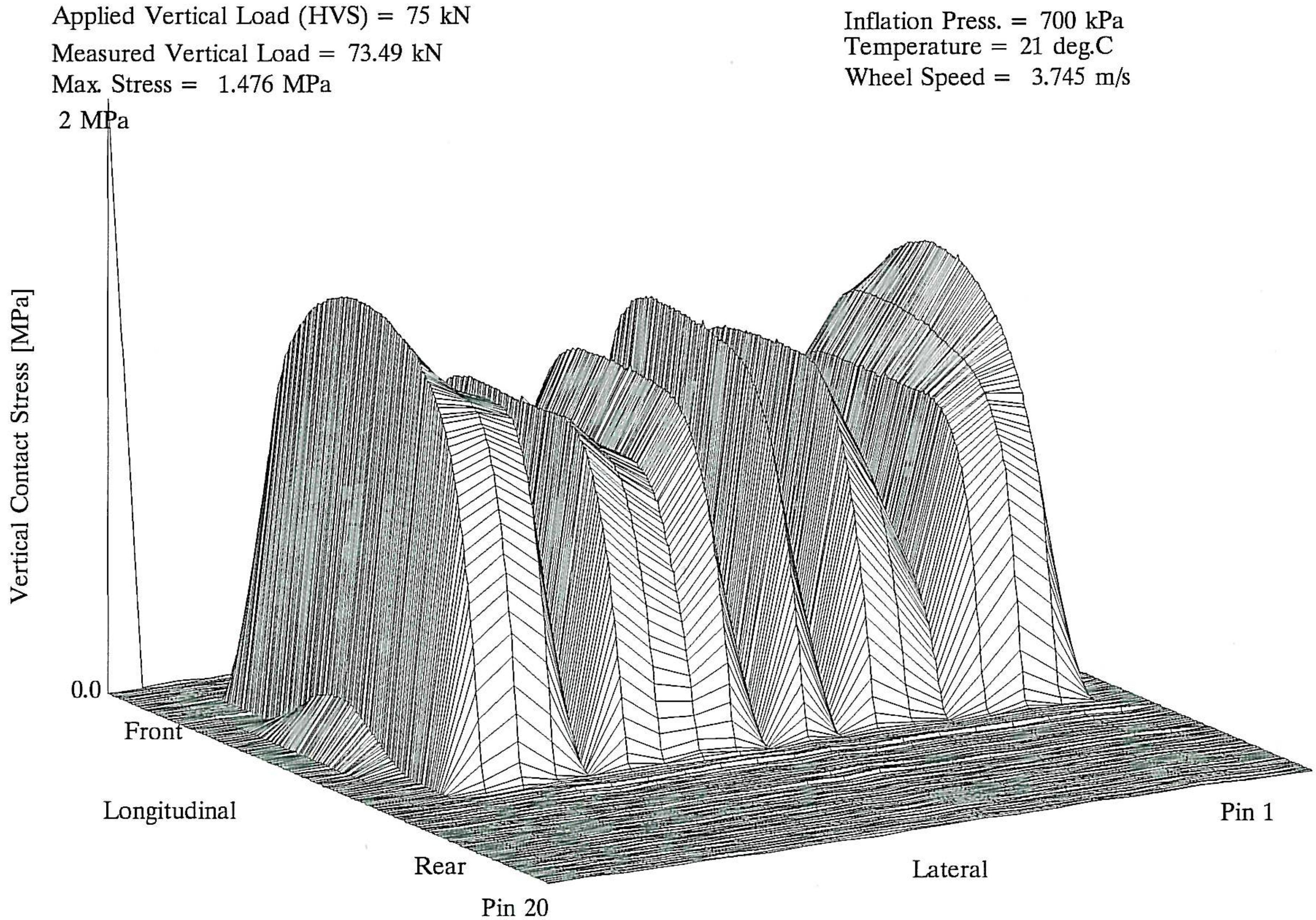
Inflation Press. = 700 kPa
Temperature = 20 deg.C
Wheel Speed = 3.626 m/s



Used Bridgestone 425/65R22.5 R160AZ

Filename : nost75ax

FIGURE B5X



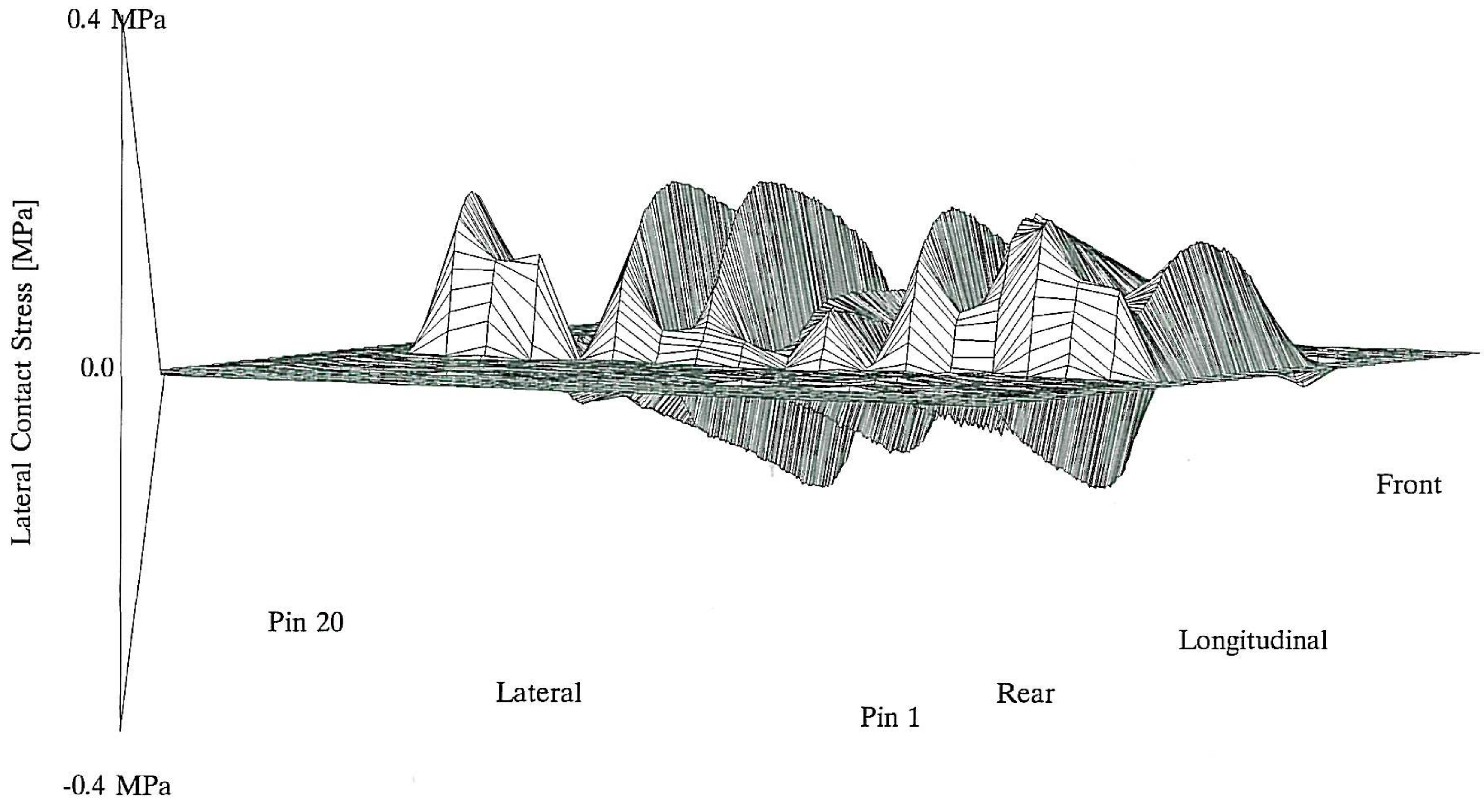
Used Bridgestone 425/65R22.5 R160AZ

Filename : nost77az

FIGURE B6Z

Applied Vertical Load (HVS) = 75 kN
Measured Lateral Load = 2.652 kN
Max. Stress = 0.1979 MPa
Min. Stress = -0.1584 MPa

Inflation Press. = 700 kPa
Temperature = 21 deg.C
Wheel Speed = 3.745 m/s



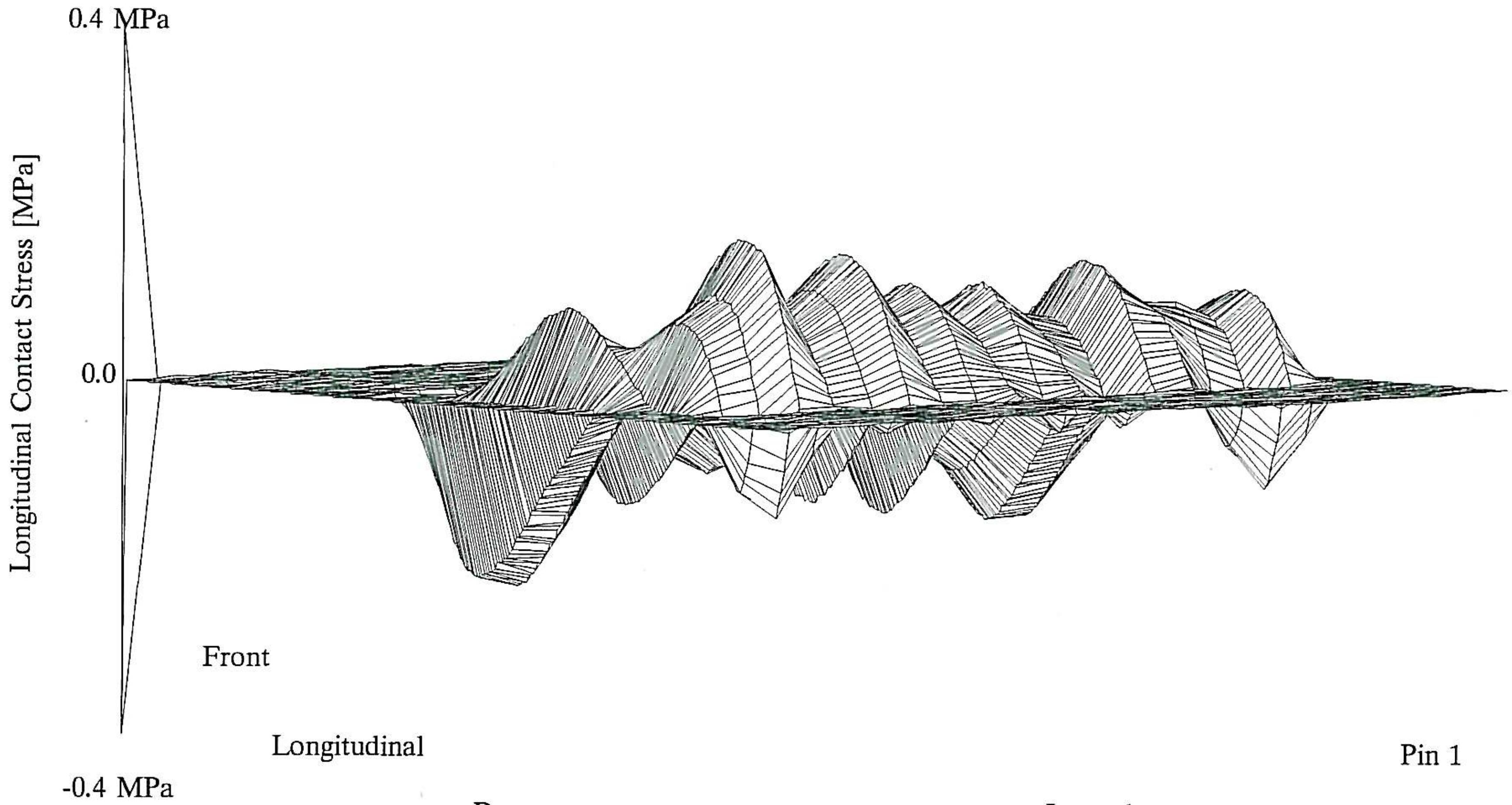
Used Bridgestone 425/65R22.5 R160AZ

FIGURE B6Y

Filename : nost77ay

Applied Vertical Load (HVS) = 75 kN
Measured Longitudinal Load = 0.1272 kN
Max. Stress = 0.1867 MPa
Min. Stress = -0.2197 MPa

Inflation Press. = 700 kPa
Temperature = 21 deg.C
Wheel Speed = 3.745 m/s



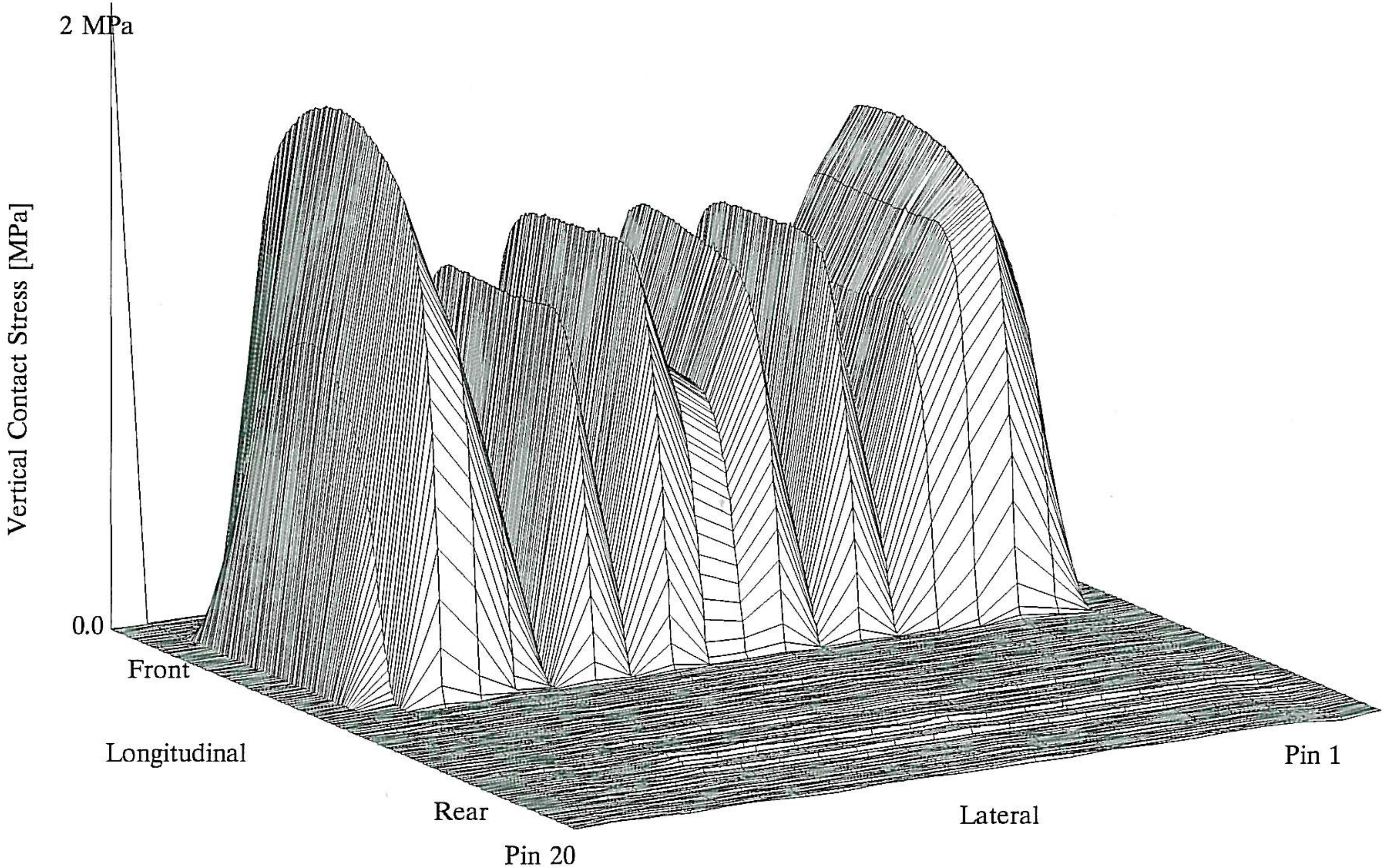
Used Bridgestone 425/65R22.5 R160AZ

FIGURE B6X

Filename : nost77ax

Applied Vertical Load (HVS) = 100 kN
Measured Vertical Load = 100.3 kN
Max. Stress = 1.764 MPa

Inflation Press. = 700 kPa
Temperature = 21 deg.C
Wheel Speed = 3.765 m/s



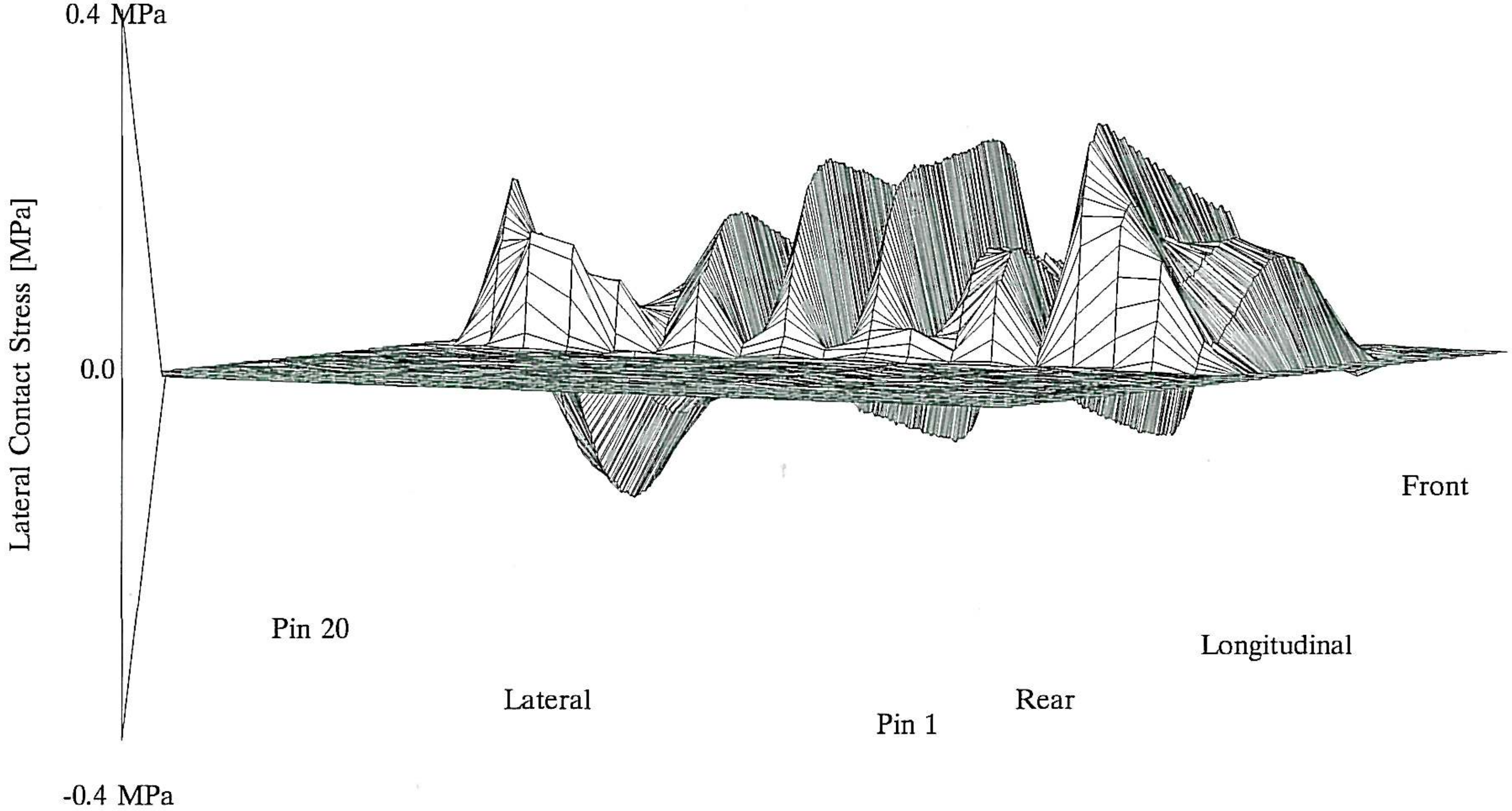
Used Bridgestone 425/65R22.5 R160AZ

Filename : nost71az

FIGURE B7Z

Applied Vertical Load (HVS) = 100 kN
Measured Lateral Load = 5.023 kN
Max. Stress = 0.2655 MPa
Min. Stress = -0.1746 MPa

Inflation Press. = 700 kPa
Temperature = 21 deg.C
Wheel Speed = 3.765 m/s



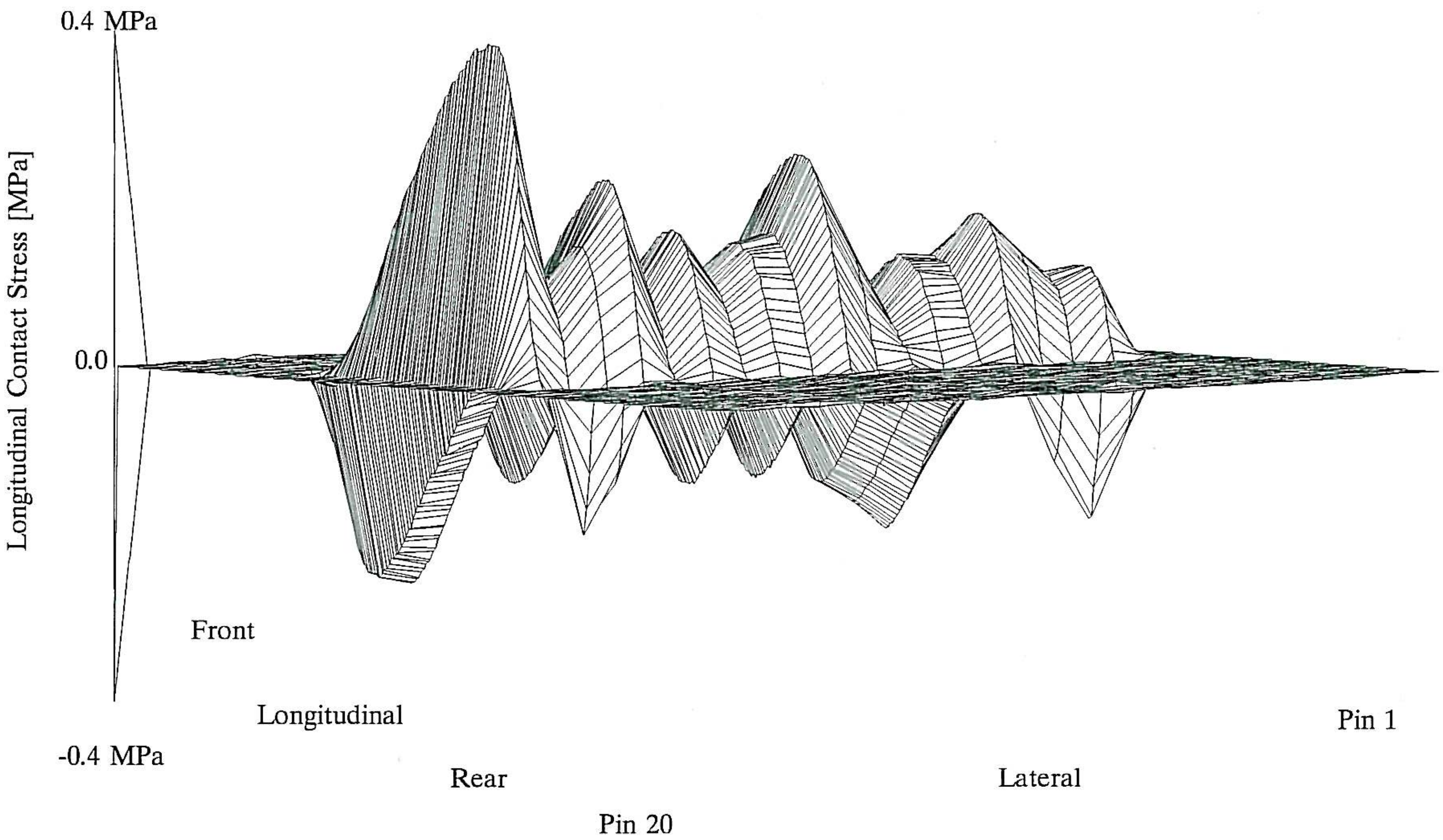
Used Bridgestone 425/65R22.5 R160AZ

FIGURE B7Y

Filename : nost71ay

Applied Vertical Load (HVS) = 100 kN
Measured Longitudinal Load = 2.329 kN
Max. Stress = 0.4074 MPa
Min. Stress = -0.2541 MPa

Inflation Press. = 700 kPa
Temperature = 21 deg.C
Wheel Speed = 3.765 m/s



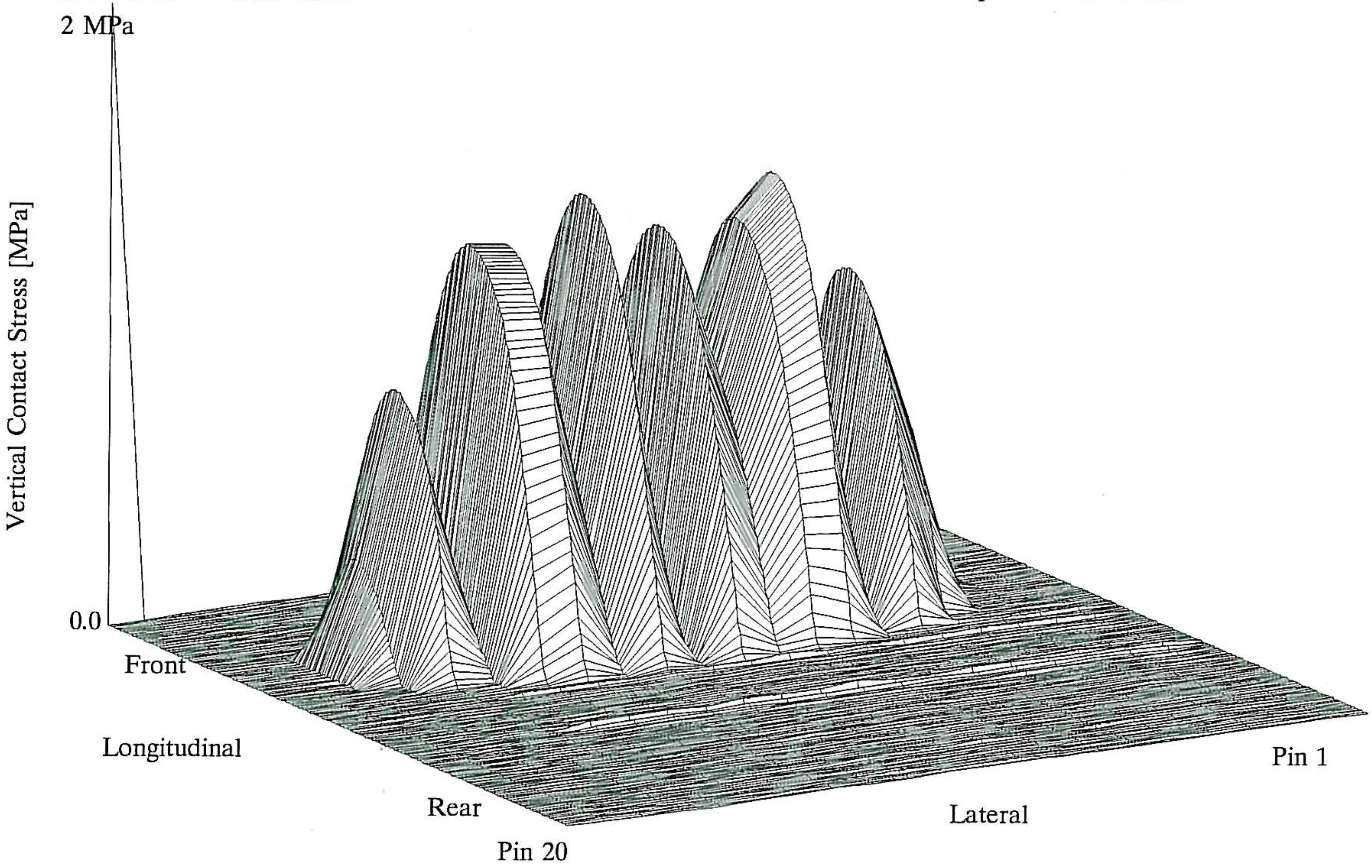
Used Bridgestone 425/65R22.5 R160AZ

Filename : nost71ax

FIGURE B7X

Applied Vertical Load (HVS) = 25 kN
Measured Vertical Load = 23.65 kN
Max. Stress = 1.419 MPa

Inflation Press. = 900 kPa
Temperature = 25 deg.C
Wheel Speed = 2.973 m/s



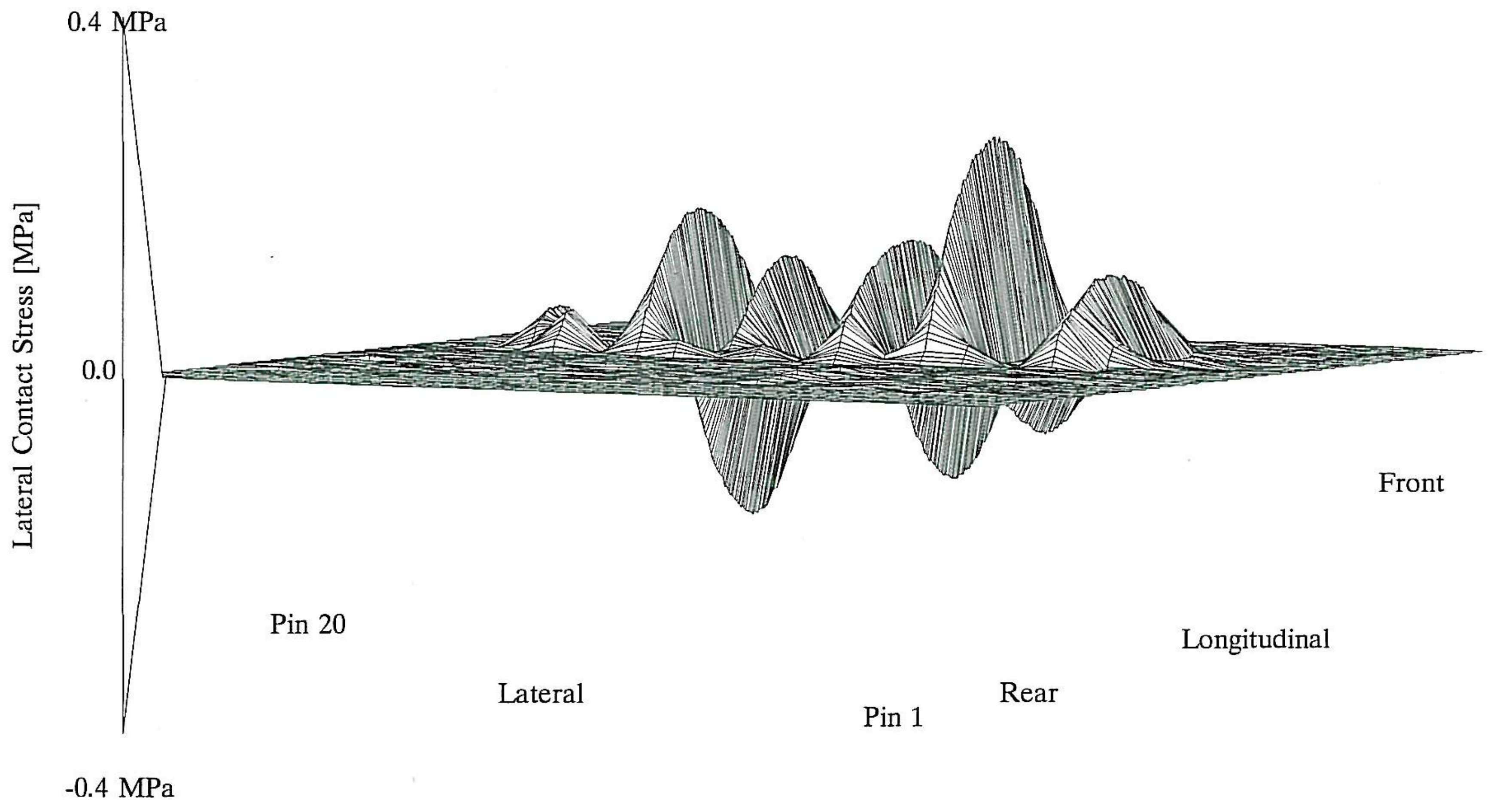
Used Bridgestone 425/65R22.5 R160AZ

Filename : not902az

FIGURE B8Z

Applied Vertical Load (HVS) = 25 kN
Measured Lateral Load = 0.5897 kN
Max. Stress = 0.2462 MPa
Min. Stress = -0.1852 MPa

Inflation Press. = 900 kPa
Temperature = 25 deg.C
Wheel Speed = 2.973 m/s



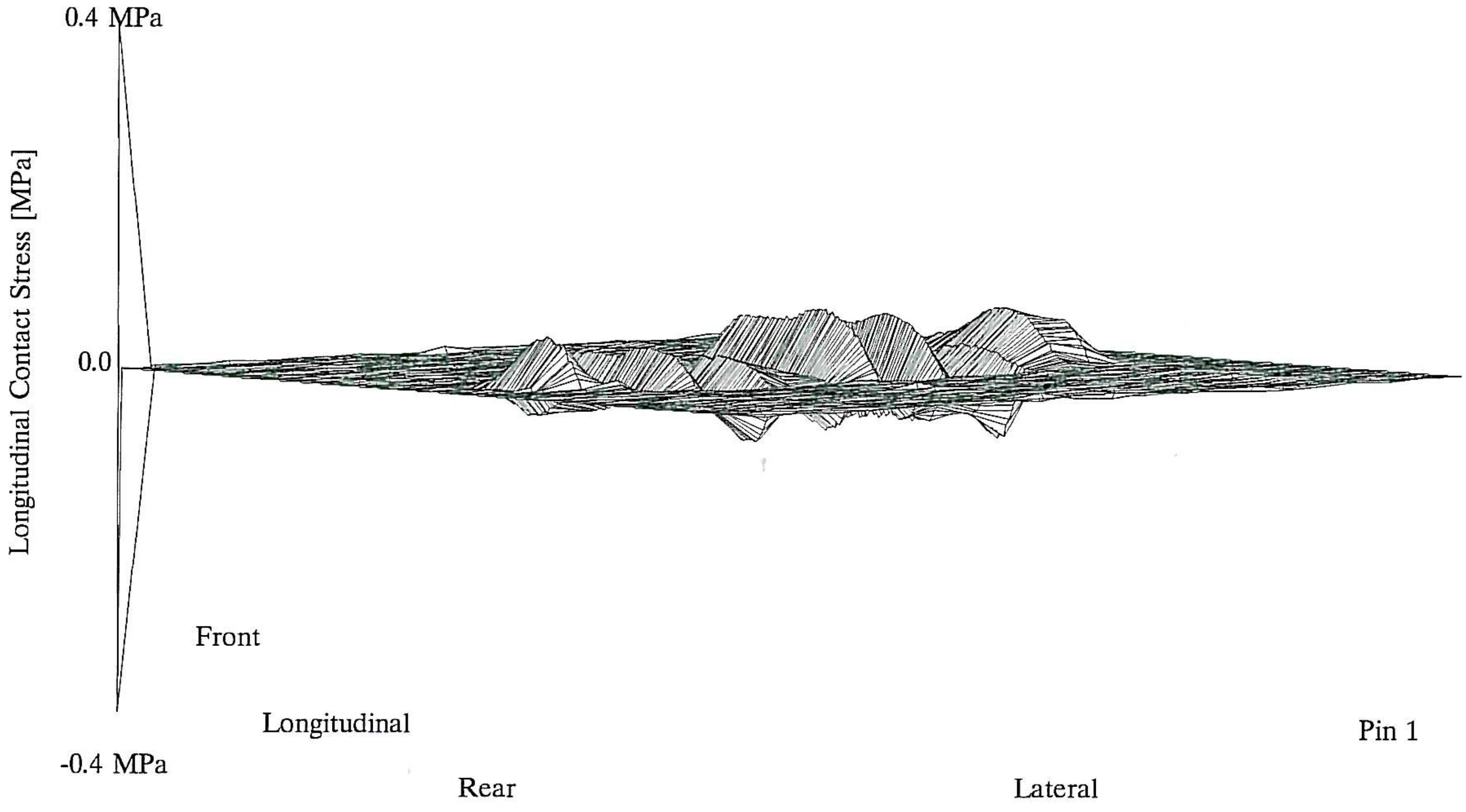
Used Bridgestone 425/65R22.5 R160AZ

Filename : not902ay

FIGURE B8Y

Applied Vertical Load (HVS) = 25 kN
Measured Longitudinal Load = 0.09958 kN
Max. Stress = 0.07607 MPa
Min. Stress = -0.07528 MPa

Inflation Press. = 900 kPa
Temperature = 25 deg.C
Wheel Speed = 2.973 m/s



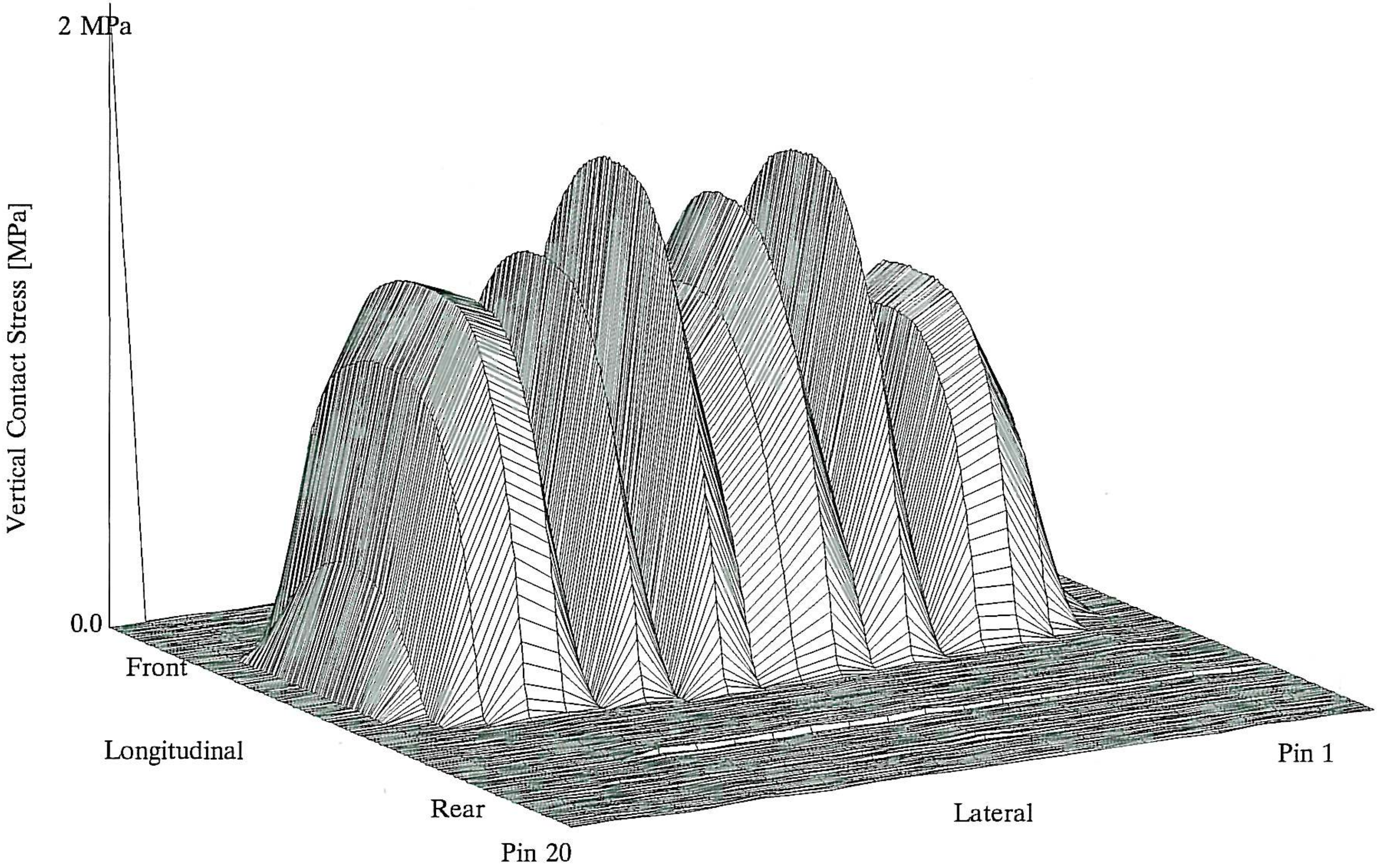
Used Bridgestone 425/65R22.5 R160AZ

Filename : not902ax

FIGURE B8X

Applied Vertical Load (HVS) = 50 kN
Measured Vertical Load = 45.24 kN
Max. Stress = 1.563 MPa

Inflation Press. = 900 kPa
Temperature = 25 deg.C
Wheel Speed = 2.831 m/s



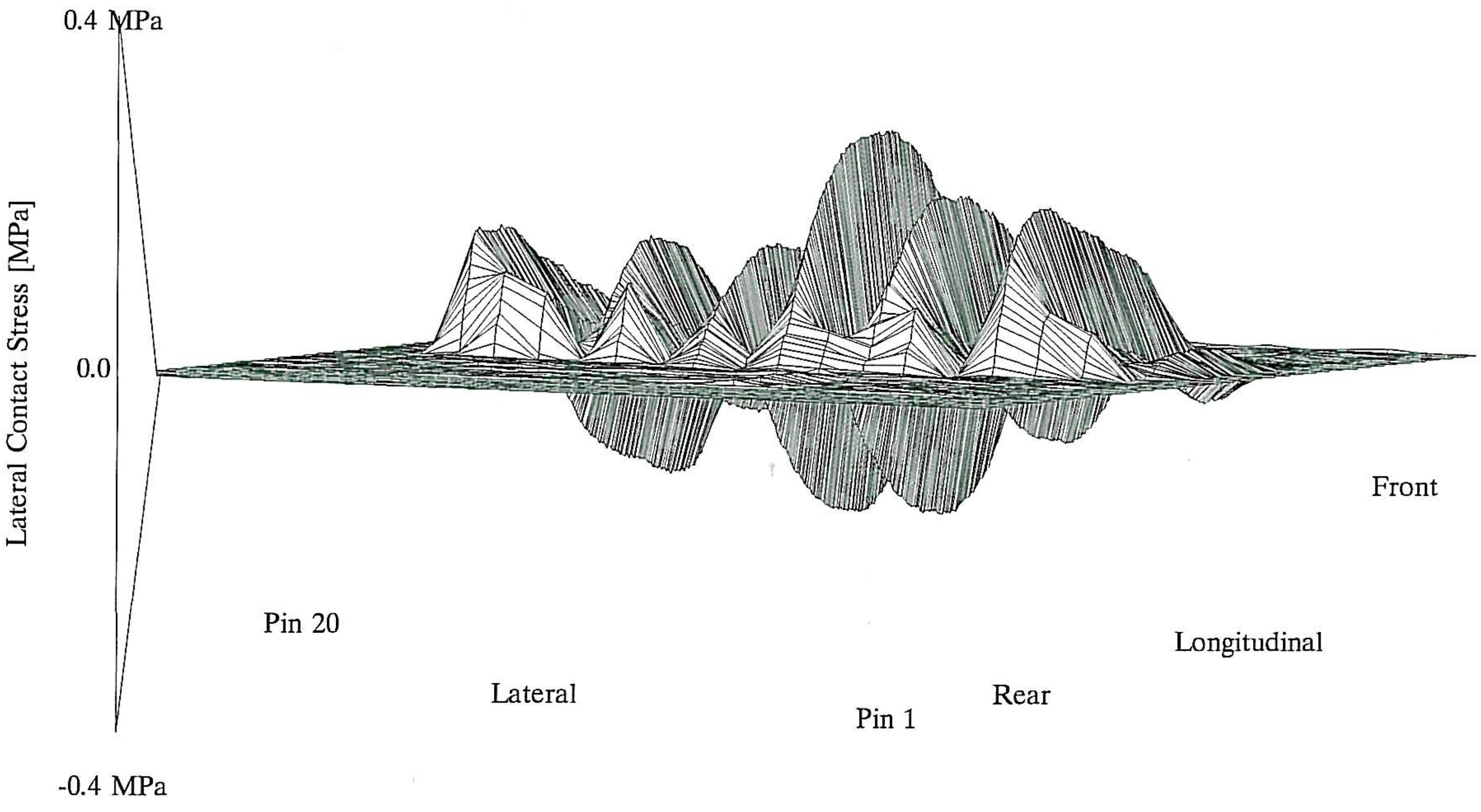
Used Bridgestone 425/65R22.5 R160AZ

Filename : not905cz

FIGURE B9Z

Applied Vertical Load (HVS) = 50 kN
Measured Lateral Load = 1.454 kN
Max. Stress = 0.2542 MPa
Min. Stress = -0.175 MPa

Inflation Press. = 900 kPa
Temperature = 25 deg.C
Wheel Speed = 2.831 m/s



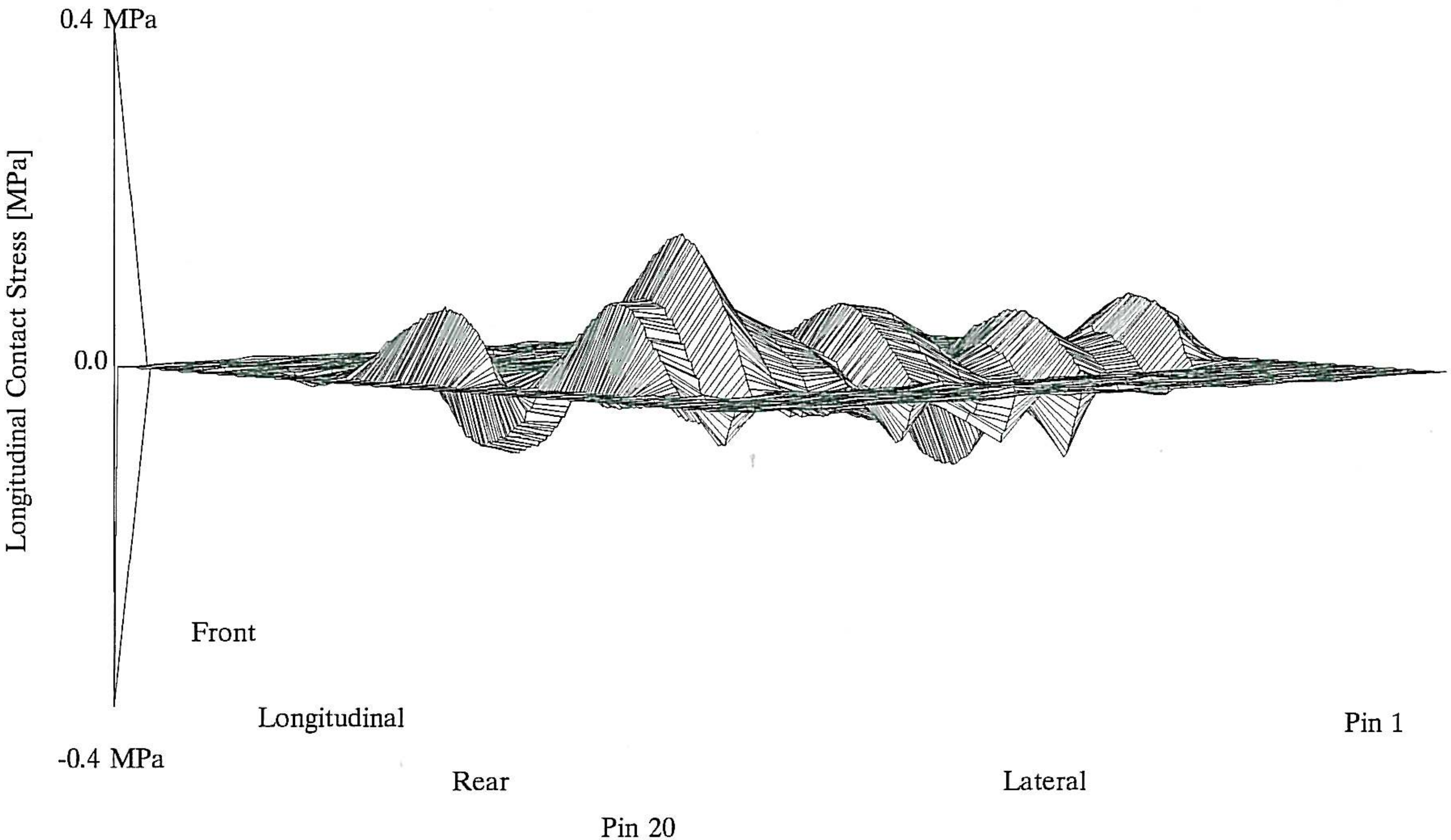
Used Bridgestone 425/65R22.5 R160AZ

FIGURE B9Y

Filename : not905cy

Applied Vertical Load (HVS) = 50 kN
Measured Longitudinal Load = 0.3739 kN
Max. Stress = 0.18 MPa
Min. Stress = -0.1244 MPa

Inflation Press. = 900 kPa
Temperature = 25 deg.C
Wheel Speed = 2.831 m/s



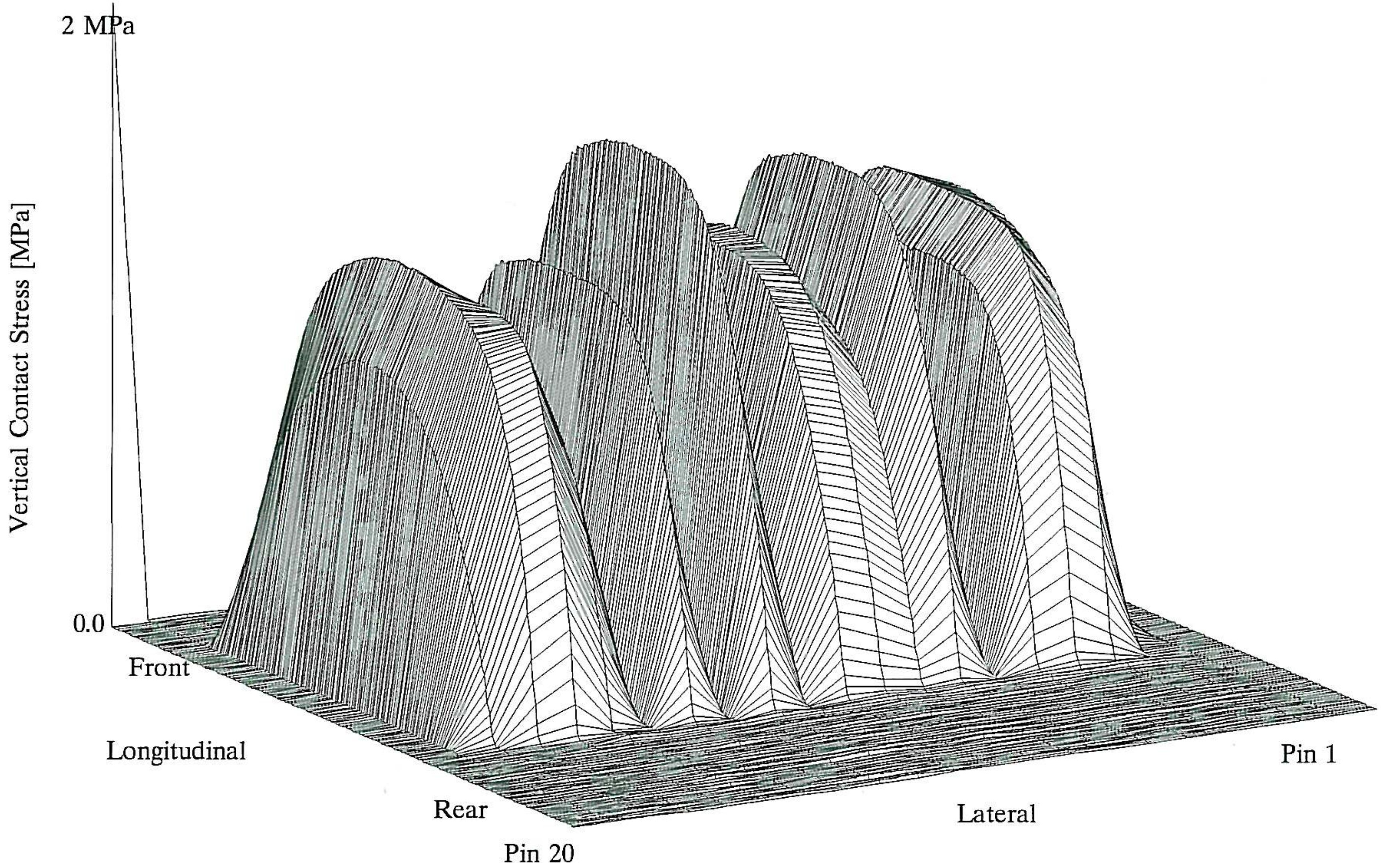
Used Bridgestone 425/65R22.5 R160AZ

Filename : not905cx

FIGURE B9X

Applied Vertical Load (HVS) = 75 kN
Measured Vertical Load = 71.43 kN
Max. Stress = 1.634 MPa

Inflation Press. = 900 kPa
Temperature = 24 deg.C
Wheel Speed = 2.98 m/s



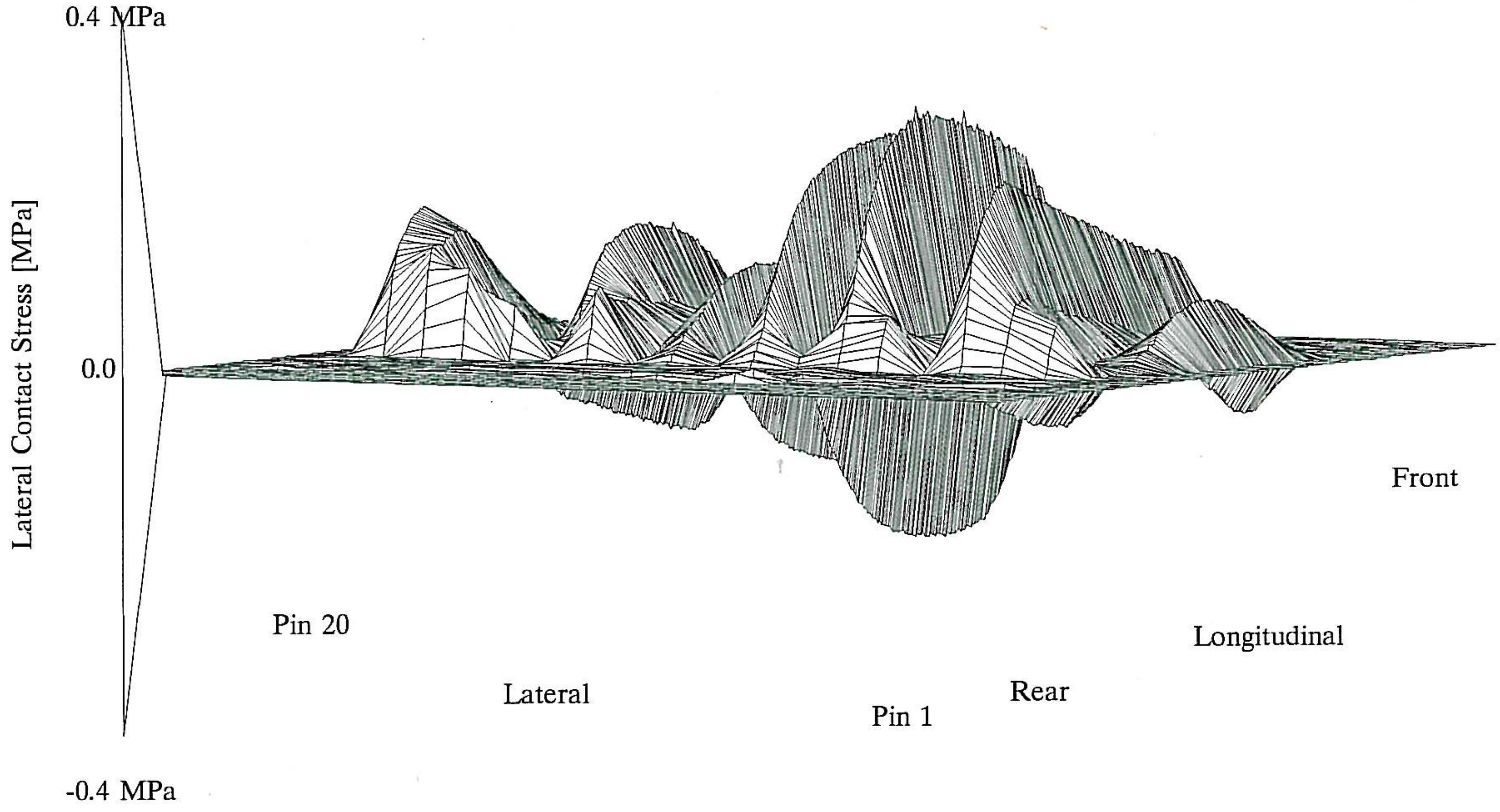
Used Bridgestone 425/65R22.5 R160AZ

FIGURE B10Z

Filename : not907az

Applied Vertical Load (HVS) = 75 kN
Measured Lateral Load = 2.887 kN
Max. Stress = 0.2828 MPa
Min. Stress = -0.2022 MPa

Inflation Press. = 900 kPa
Temperature = 24 deg.C
Wheel Speed = 2.98 m/s



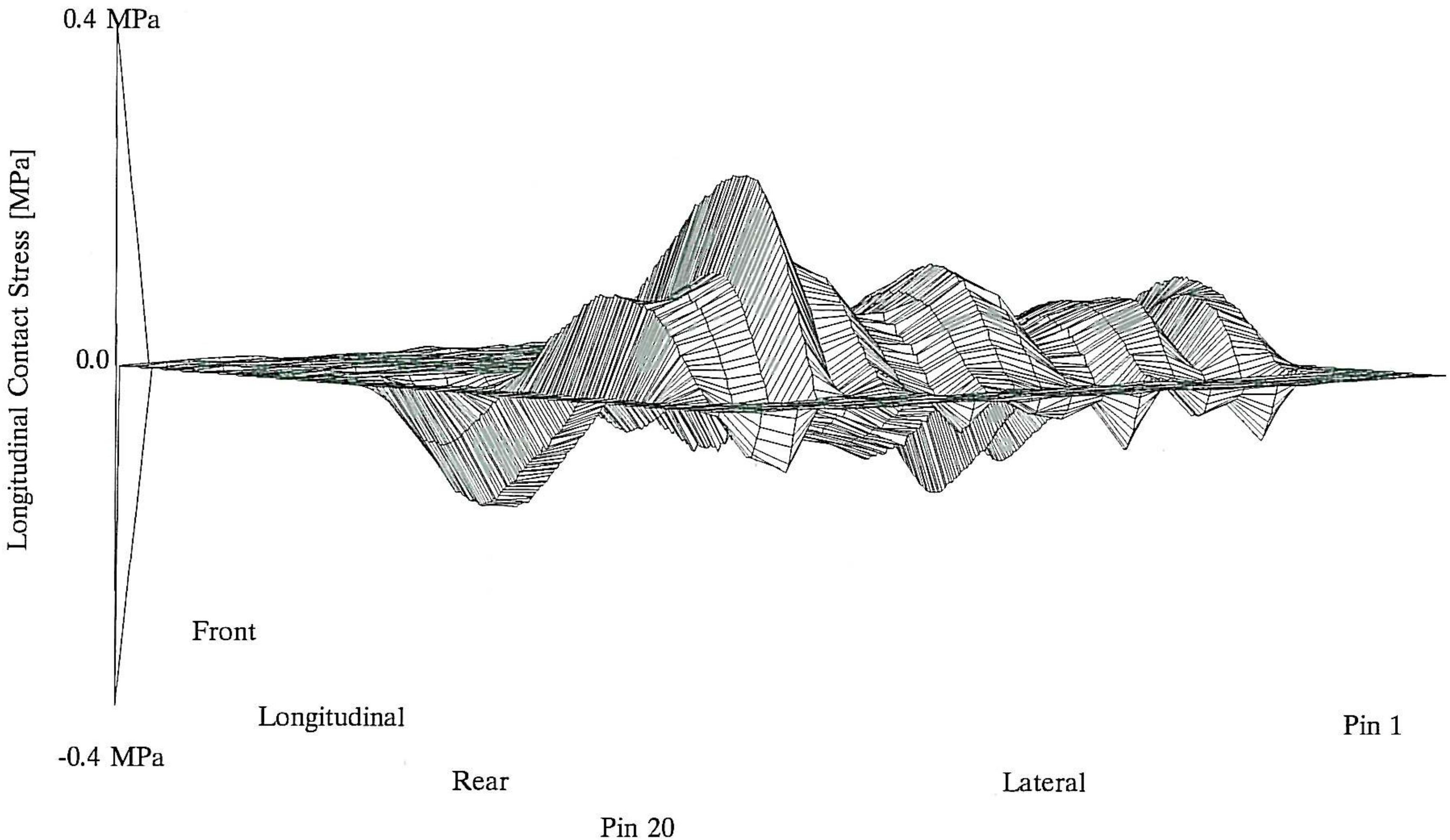
Used Bridgestone 425/65R22.5 R160AZ

FIGURE B10Y

Filename : not907ay

Applied Vertical Load (HVS) = 75 kN
Measured Longitudinal Load = 1.161 kN
Max. Stress = 0.2554 MPa
Min. Stress = -0.1572 MPa

Inflation Press. = 900 kPa
Temperature = 24 deg.C
Wheel Speed = 2.98 m/s



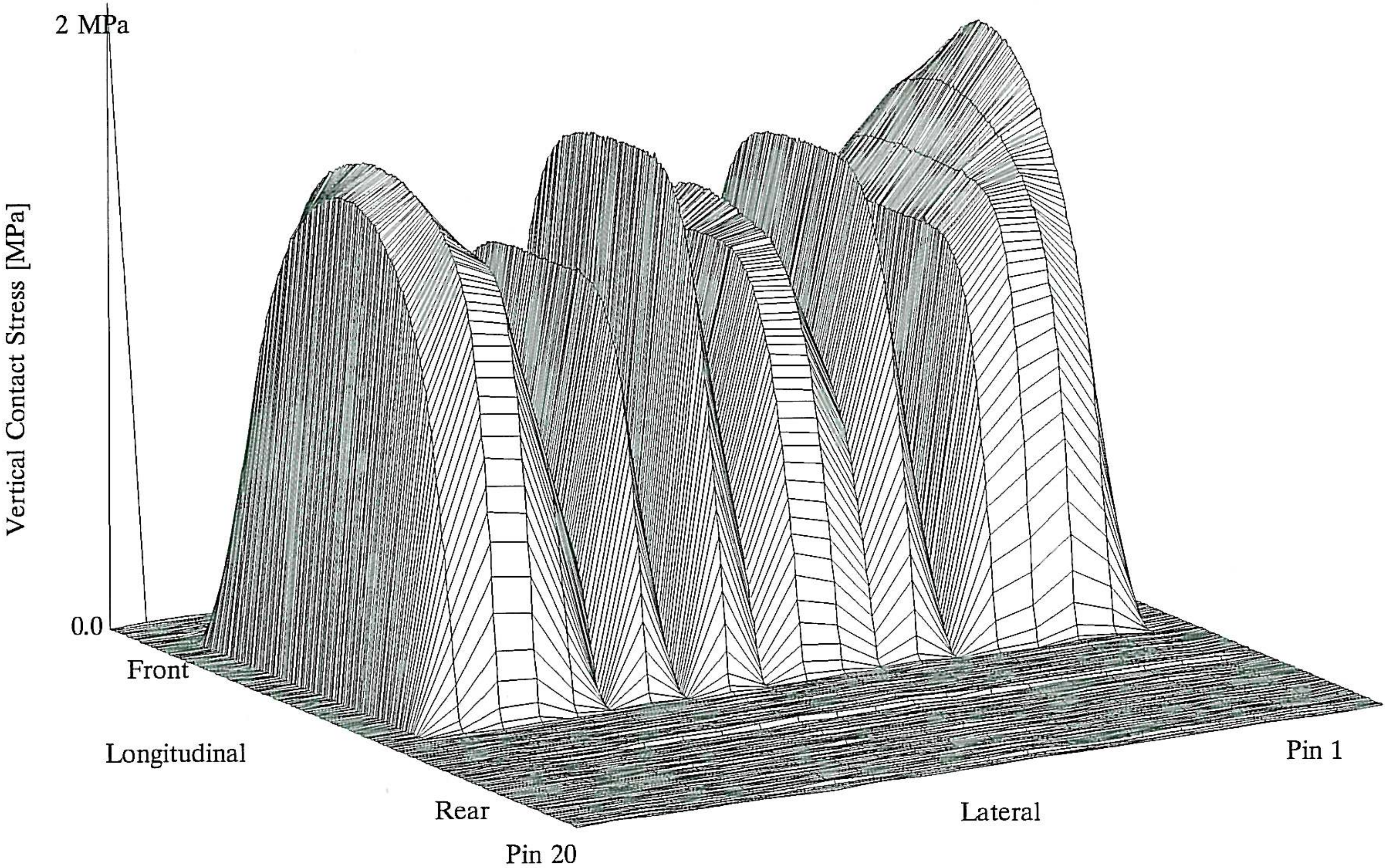
Used Bridgestone 425/65R22.5 R160AZ

Filename : not907ax

FIGURE B10X

Applied Vertical Load (HVS) = 100 kN
Measured Vertical Load = 103.4 kN
Max. Stress = 1.791 MPa

Inflation Press. = 900 kPa
Temperature = 24 deg.C
Wheel Speed = 2.807 m/s



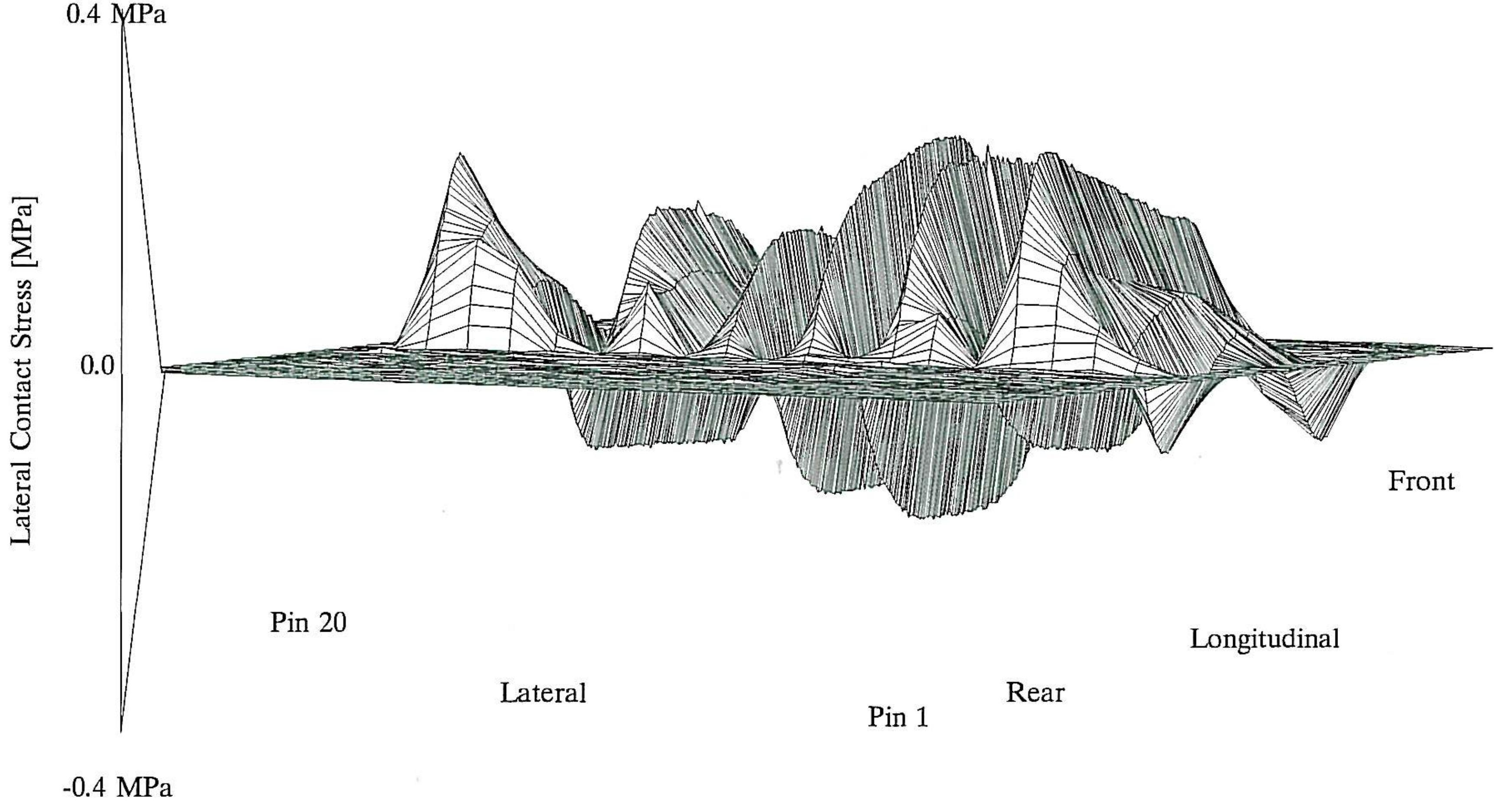
Used Bridgestone 425/65R22.5 R160AZ

FIGURE B11Z

Filename : not901az

Applied Vertical Load (HVS) = 100 kN
Measured Lateral Load = 3.048 kN
Max. Stress = 0.2374 MPa
Min. Stress = -0.1821 MPa

Inflation Press. = 900 kPa
Temperature = 24 deg.C
Wheel Speed = 2.807 m/s



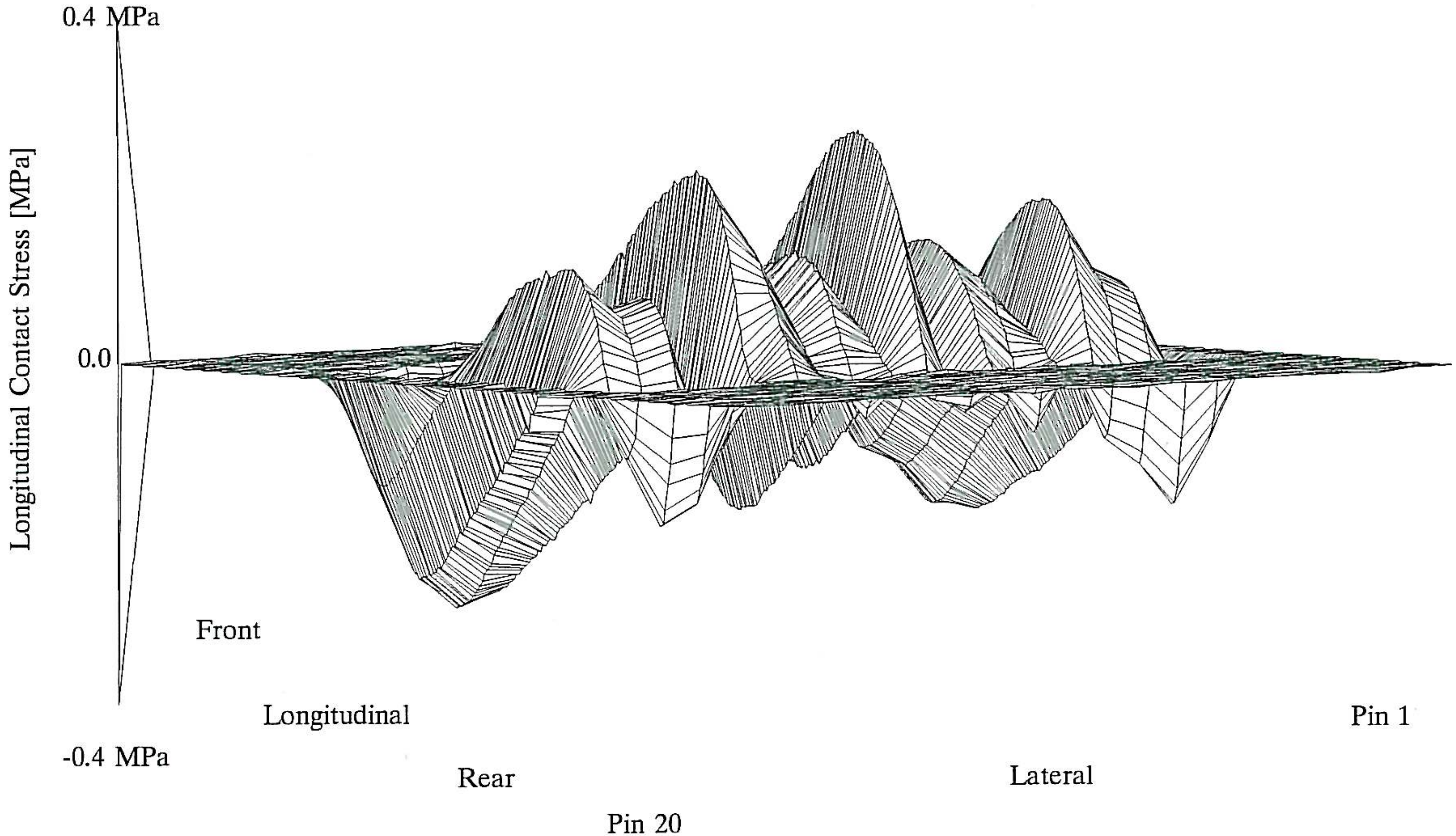
Filename : not901ay

Used Bridgestone 425/65R22.5 R160AZ

FIGURE B11Y

Applied Vertical Load (HVS) = 100 kN
Measured Longitudinal Load = -0.7558 kN
Max. Stress = 0.2782 MPa
Min. Stress = -0.2791 MPa

Inflation Press. = 900 kPa
Temperature = 24 deg.C
Wheel Speed = 2.807 m/s



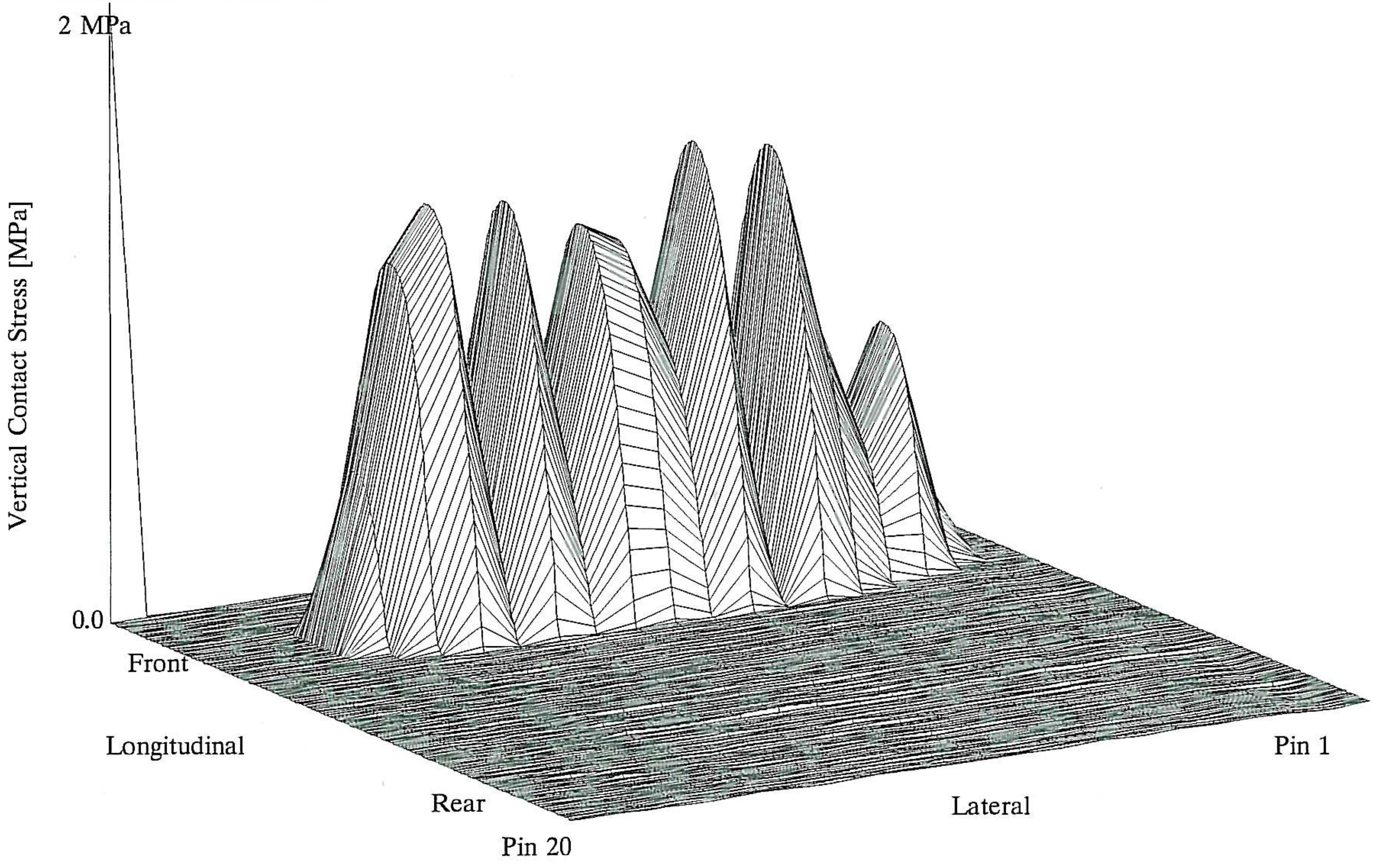
Used Bridgestone 425/65R22.5 R160AZ

Filename : not901ax

FIGURE B11X

Applied Vertical Load (HVS) = 25 kN
Measured Vertical Load = 25.29 kN
Max. Stress = 1.446 MPa

Inflation Press. = 950 kPa
Temperature = 22 deg.C
Wheel Speed = 2.803 m/s



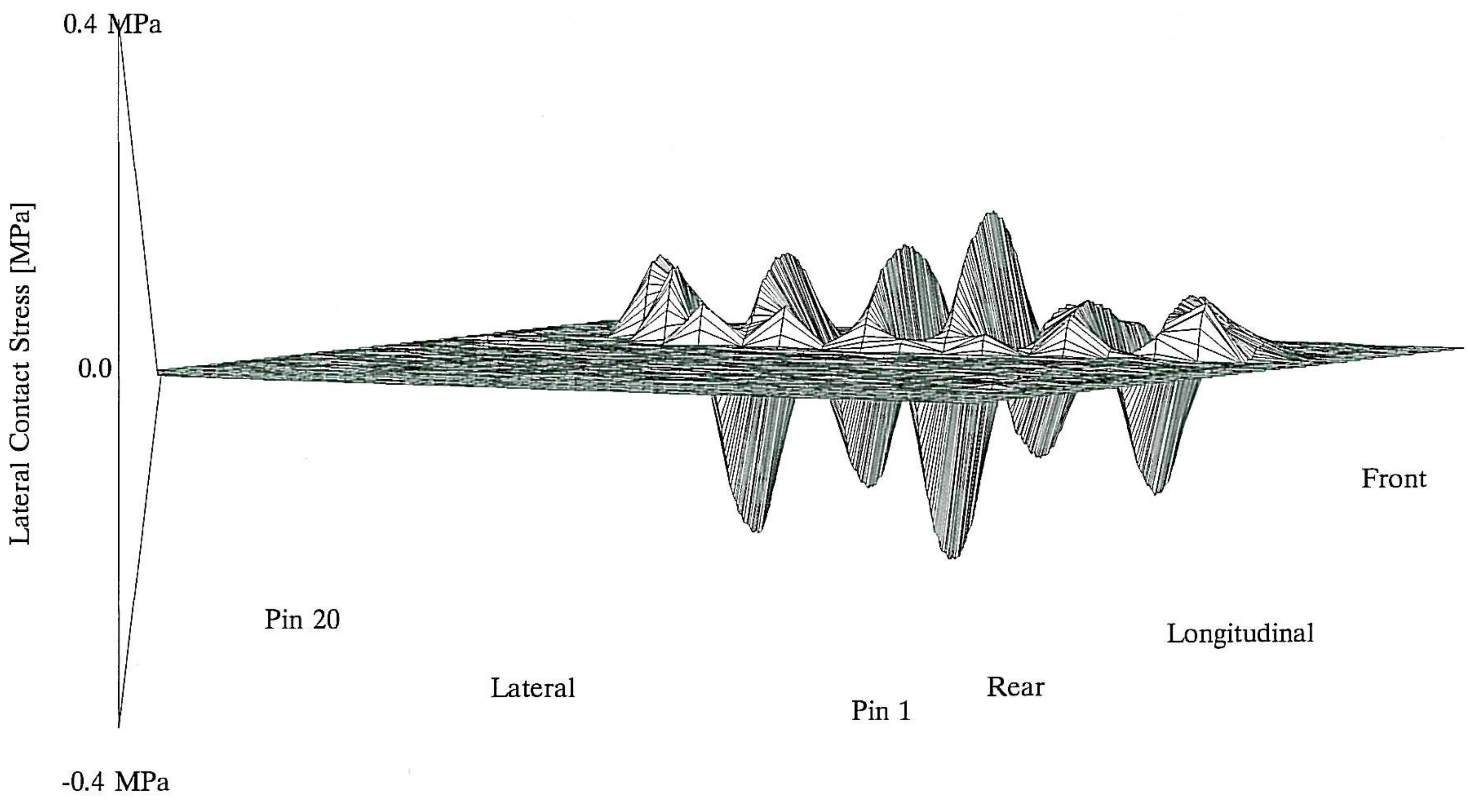
Used Bridgestone 425/65R22.5 R160AZ

Filename : nost92az

FIGURE B12Z

Applied Vertical Load (HVS) = 25 kN
Measured Lateral Load = -0.3633 kN
Max. Stress = 0.1561 MPa
Min. Stress = -0.2424 MPa

Inflation Press. = 950 kPa
Temperature = 22 deg.C
Wheel Speed = 2.803 m/s



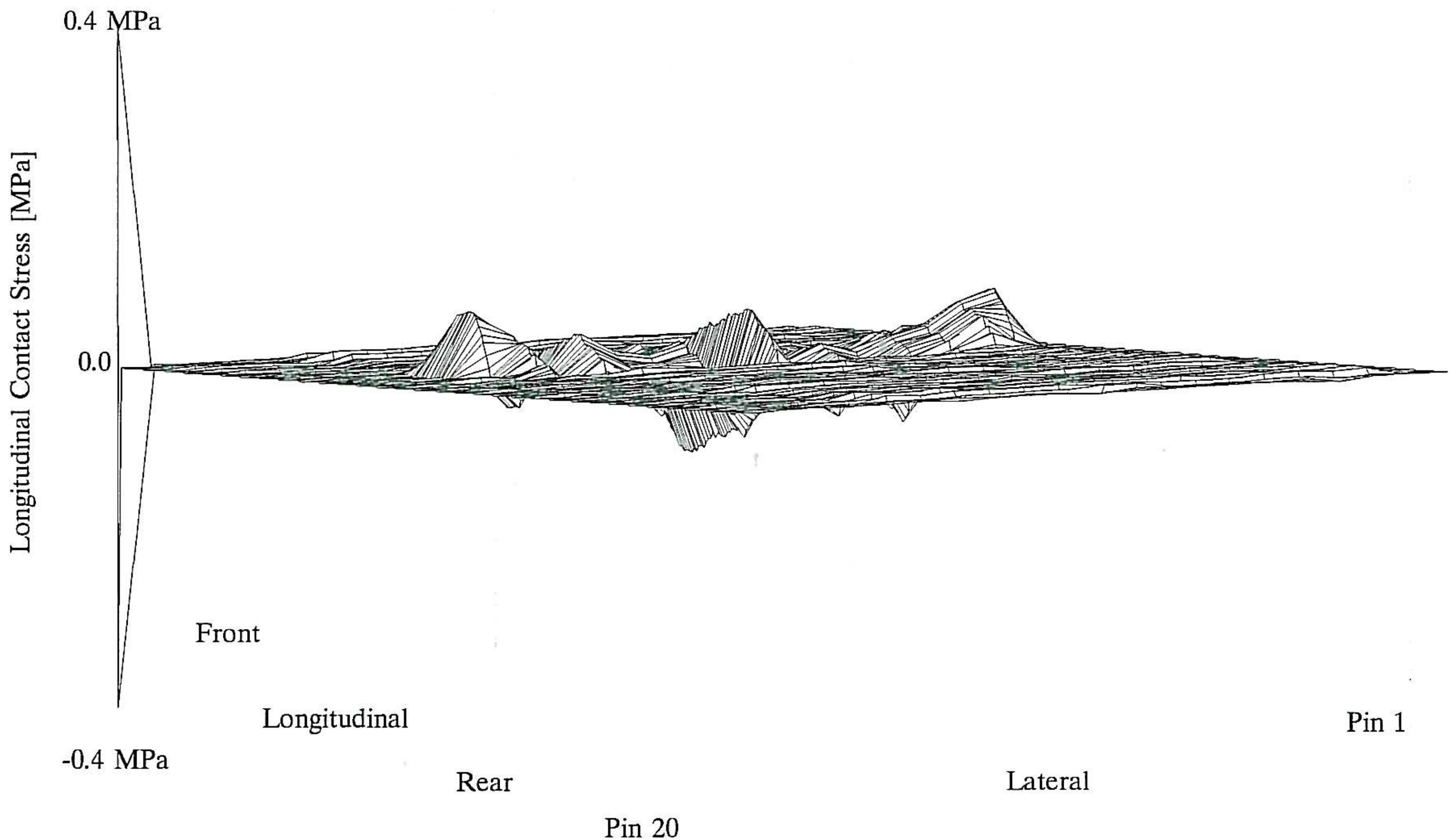
Used Bridgestone 425/65R22.5 R160AZ

Filename : nost92ay

FIGURE B12Y

Applied Vertical Load (HVS) = 25 kN
Measured Longitudinal Load = 0.3379 kN
Max. Stress = 0.07647 MPa
Min. Stress = -0.1079 MPa

Inflation Press. = 950 kPa
Temperature = 22 deg.C
Wheel Speed = 2.803 m/s



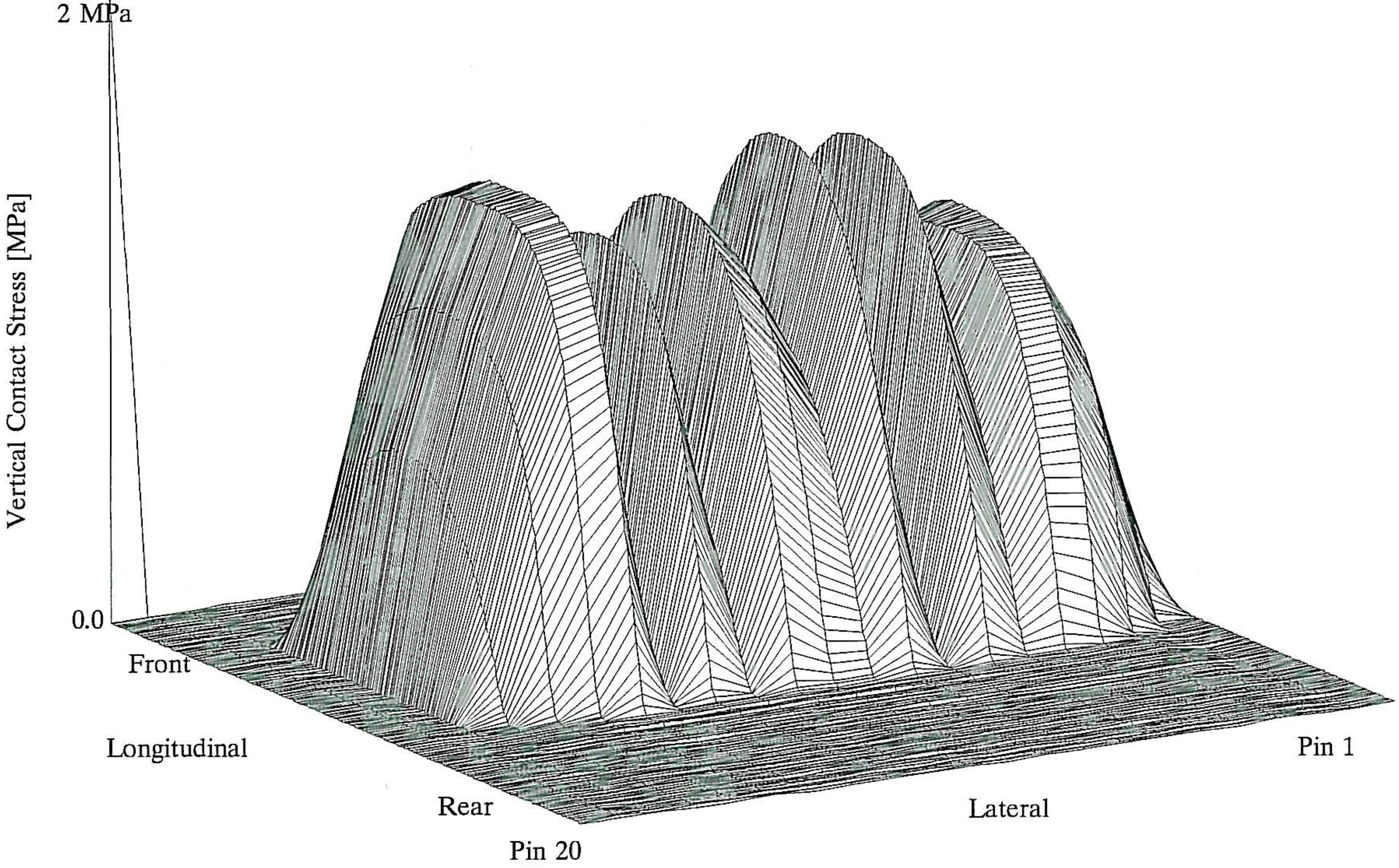
Used Bridgestone 425/65R22.5 R160AZ

Filename : nost92ax

FIGURE B12X

Applied Vertical Load (HVS) = 50 kN
Measured Vertical Load = 54.33 kN
Max. Stress = 1.535 MPa

Inflation Press. = 950 kPa
Temperature = 22 deg.C
Wheel Speed = 2.618 m/s



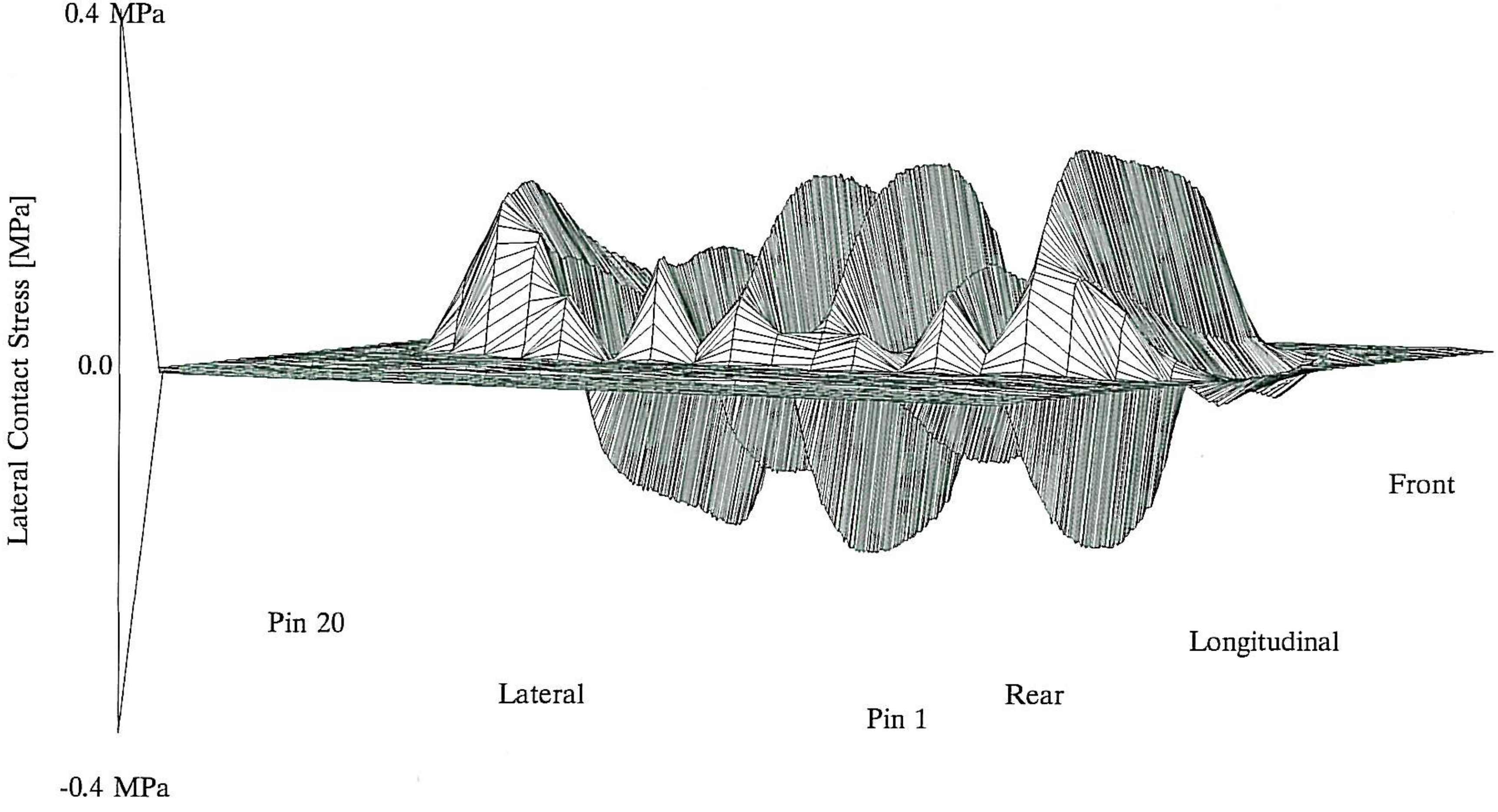
Used Bridgestone 425/65R22.5 R160AZ

Filename : nost95az

FIGURE B13Z

Applied Vertical Load (HVS) = 50 kN
Measured Lateral Load = 1.824 kN
Max. Stress = 0.2454 MPa
Min. Stress = -0.2164 MPa

Inflation Press. = 950 kPa
Temperature = 22 deg.C
Wheel Speed = 2.618 m/s



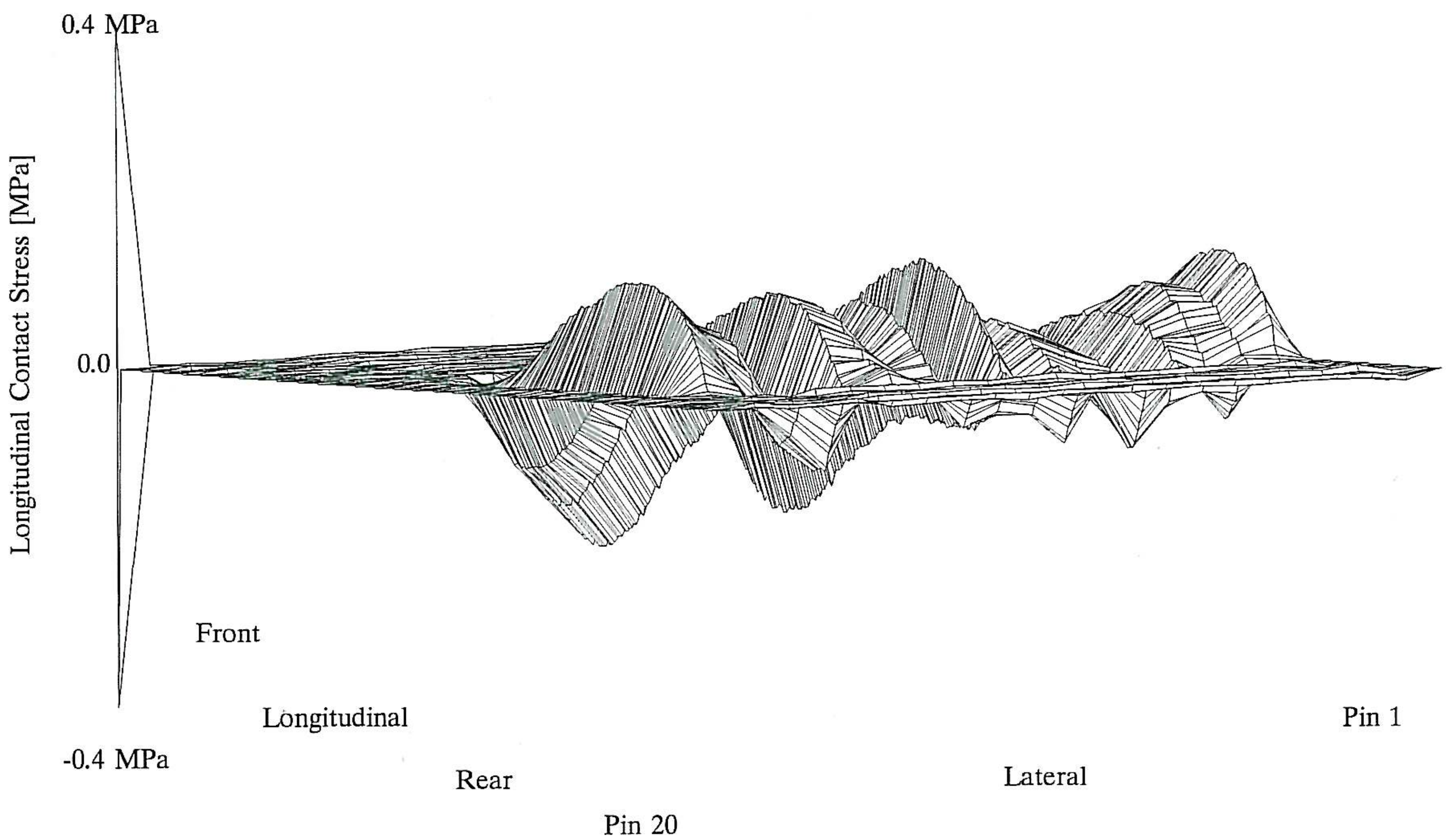
Used Bridgestone 425/65R22.5 R160AZ

FIGURE B13Y

Filename : nost95ay

Applied Vertical Load (HVS) = 50 kN
Measured Longitudinal Load = -0.1172 kN
Max. Stress = 0.1351 MPa
Min. Stress = -0.2015 MPa

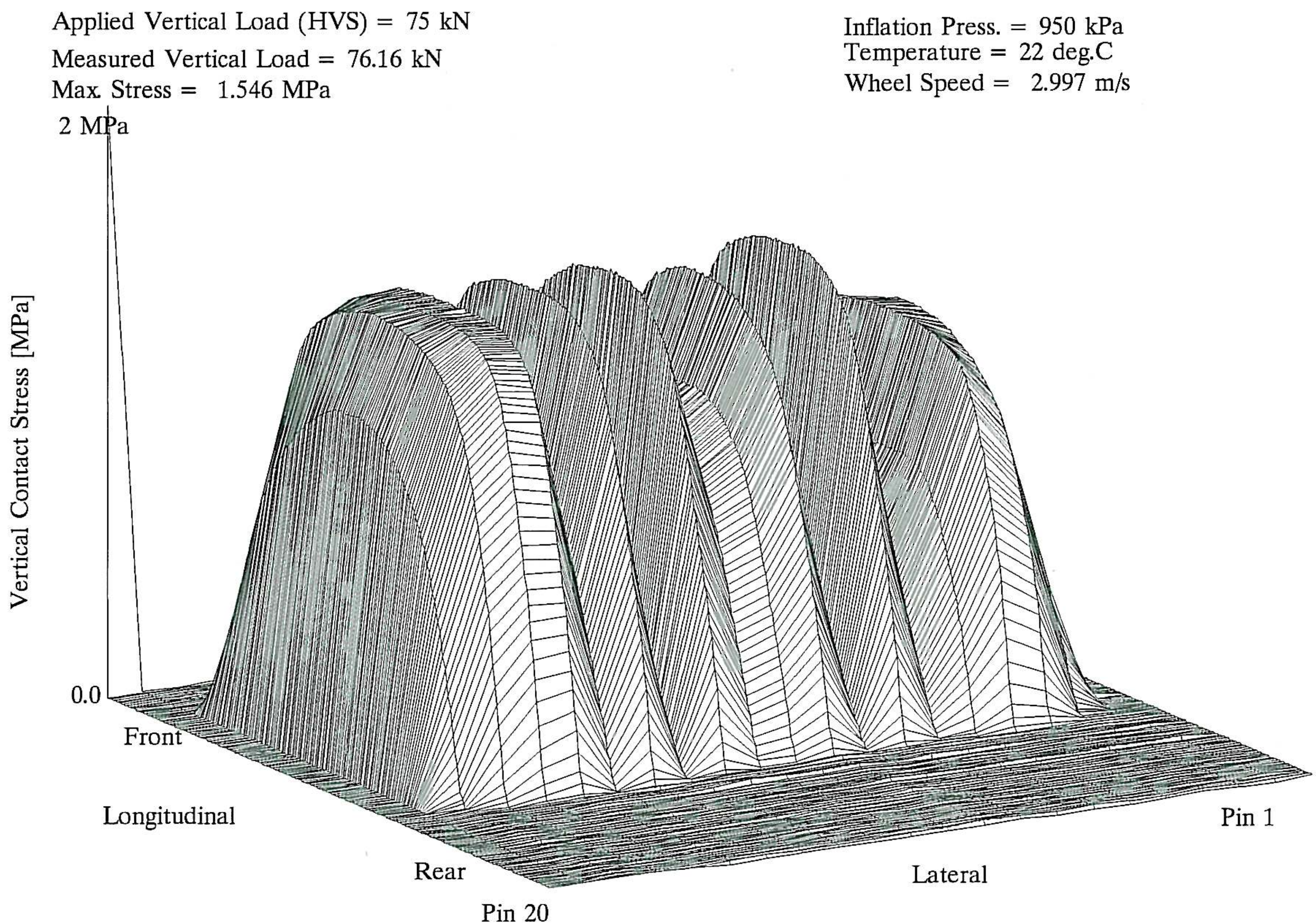
Inflation Press. = 950 kPa
Temperature = 22 deg.C
Wheel Speed = 2.618 m/s



Used Bridgestone 425/65R22.5 R160AZ

Filename : nost95ax

FIGURE B13X



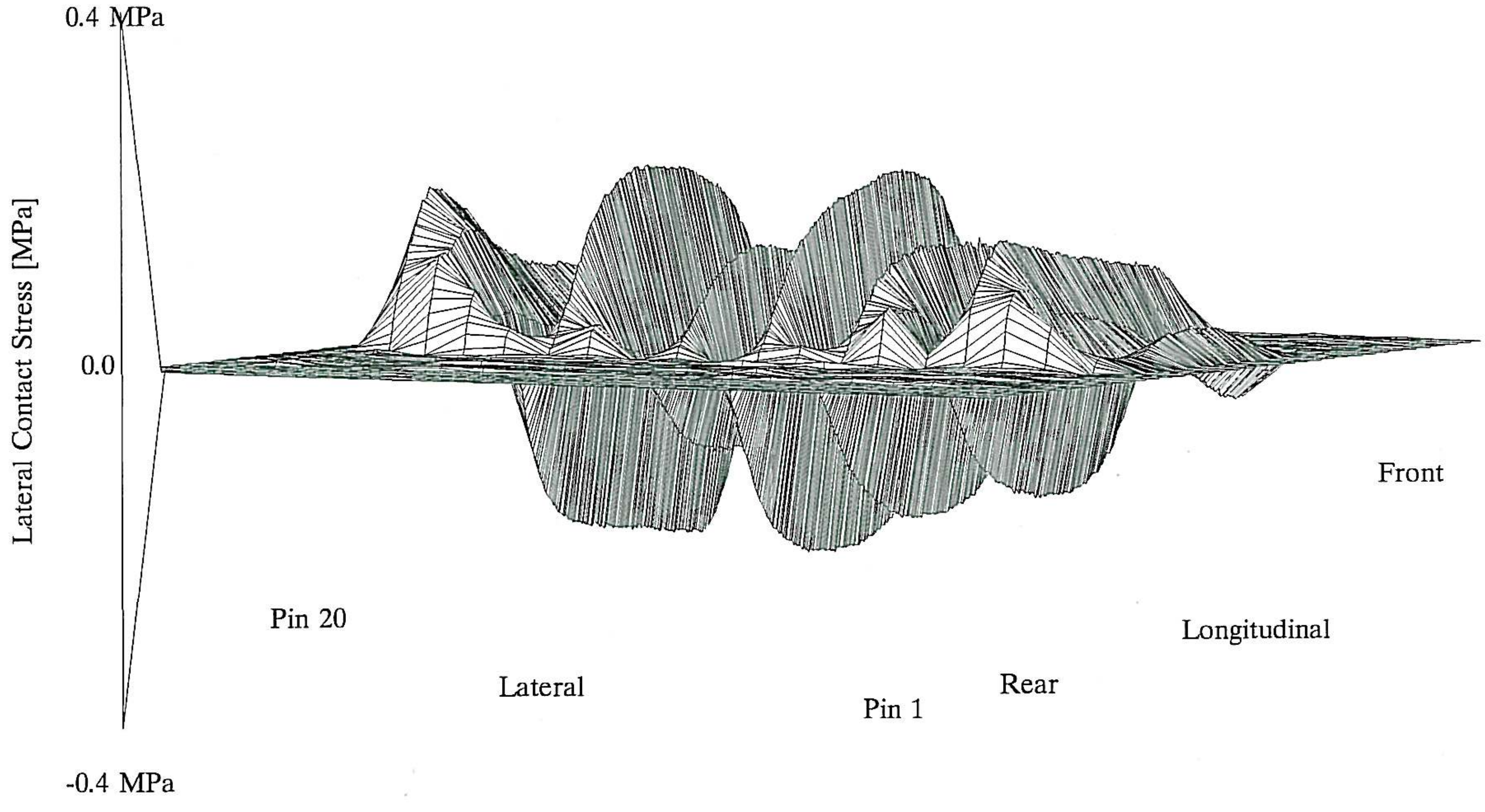
Used Bridgestone 425/65R22.5 R160AZ

Filename : nost97az

FIGURE B14Z

Applied Vertical Load (HVS) = 75 kN
Measured Lateral Load = 0.5148 kN
Max. Stress = 0.2032 MPa
Min. Stress = -0.2265 MPa

Inflation Press. = 950 kPa
Temperature = 22 deg.C
Wheel Speed = 2.997 m/s



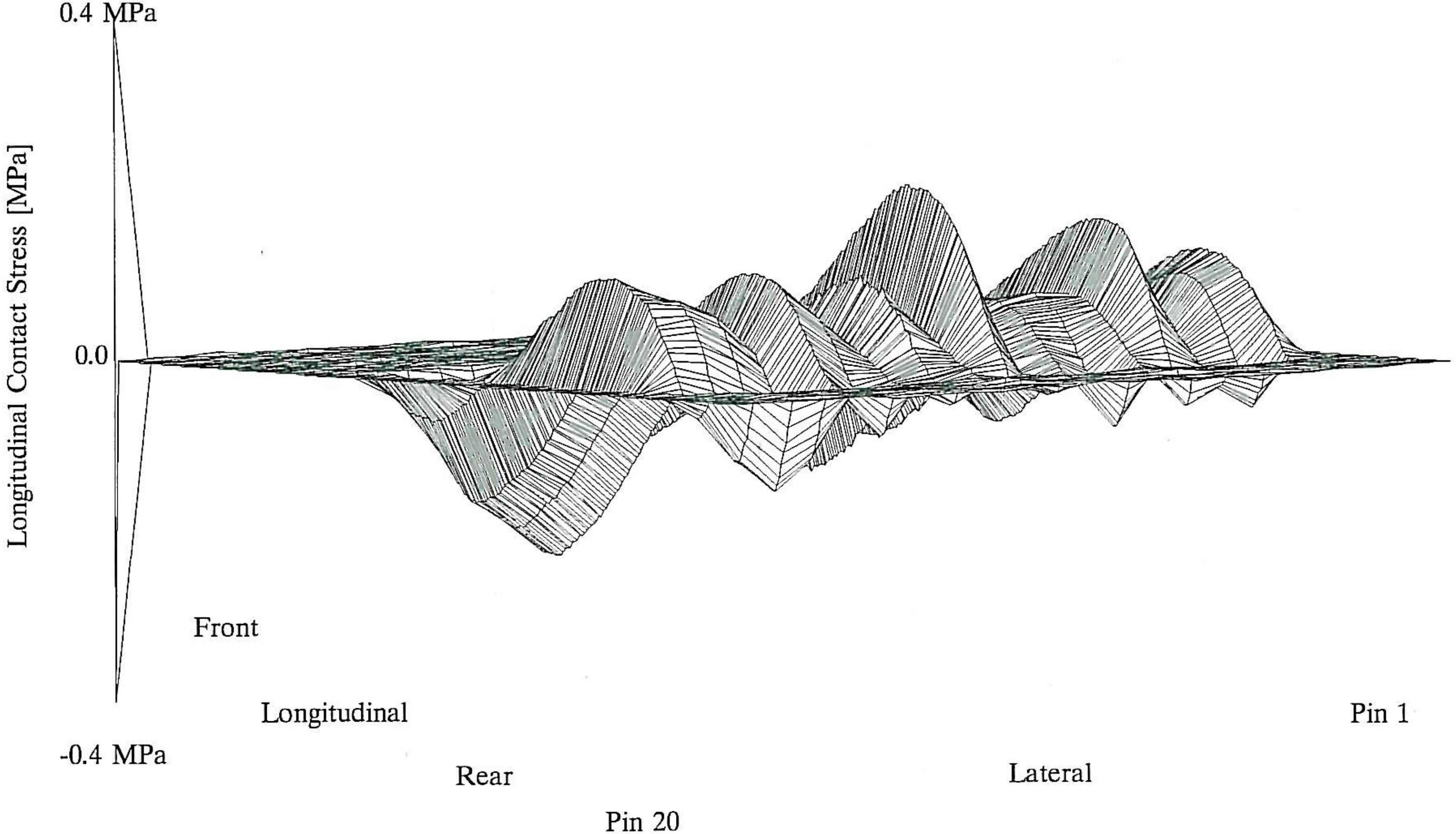
Used Bridgestone 425/65R22.5 R160AZ

FIGURE B14Y

Filename : nost97ay

Applied Vertical Load (HVS) = 75 kN
Measured Longitudinal Load = 0.5482 kN
Max. Stress = 0.2142 MPa
Min. Stress = -0.2172 MPa

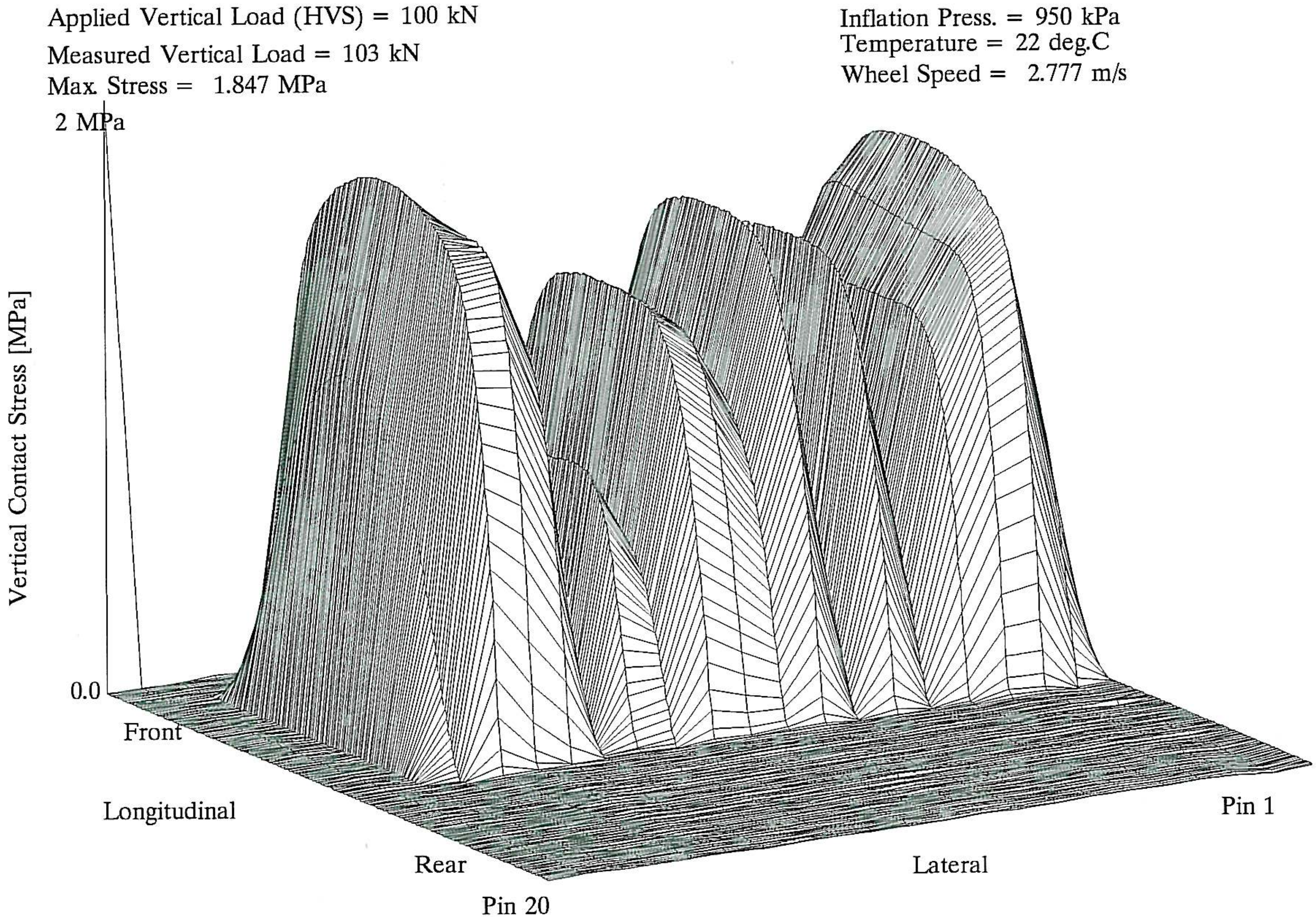
Inflation Press. = 950 kPa
Temperature = 22 deg.C
Wheel Speed = 2.997 m/s



Used Bridgestone 425/65R22.5 R160AZ

Filename : nost97ax

FIGURE B14X



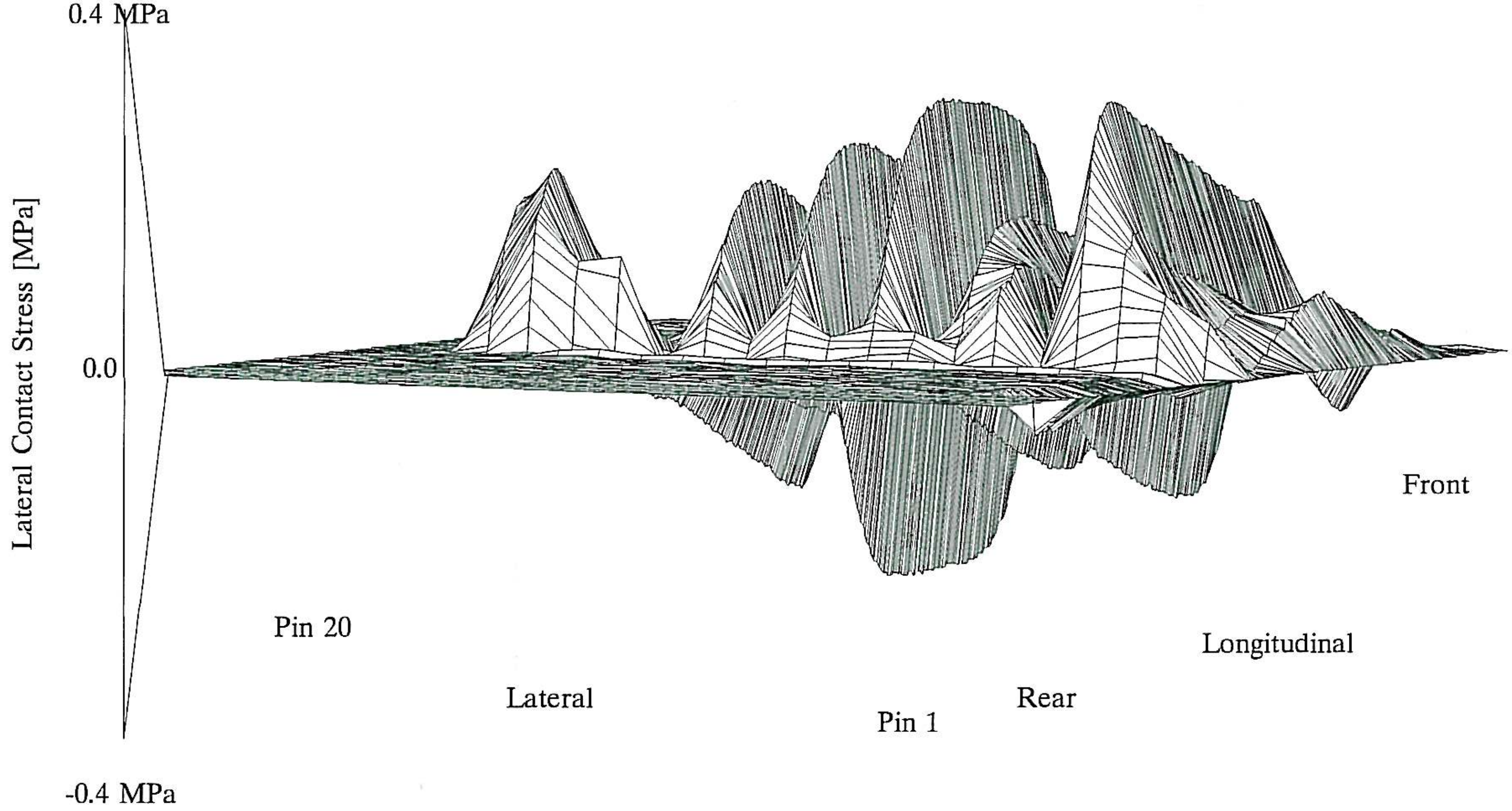
Used Bridgestone 425/65R22.5 R160AZ

Filename : nost91az

FIGURE B15Z

Applied Vertical Load (HVS) = 100 kN
Measured Lateral Load = 3.655 kN
Max. Stress = 0.2953 MPa
Min. Stress = -0.244 MPa

Inflation Press. = 950 kPa
Temperature = 22 deg.C
Wheel Speed = 2.777 m/s



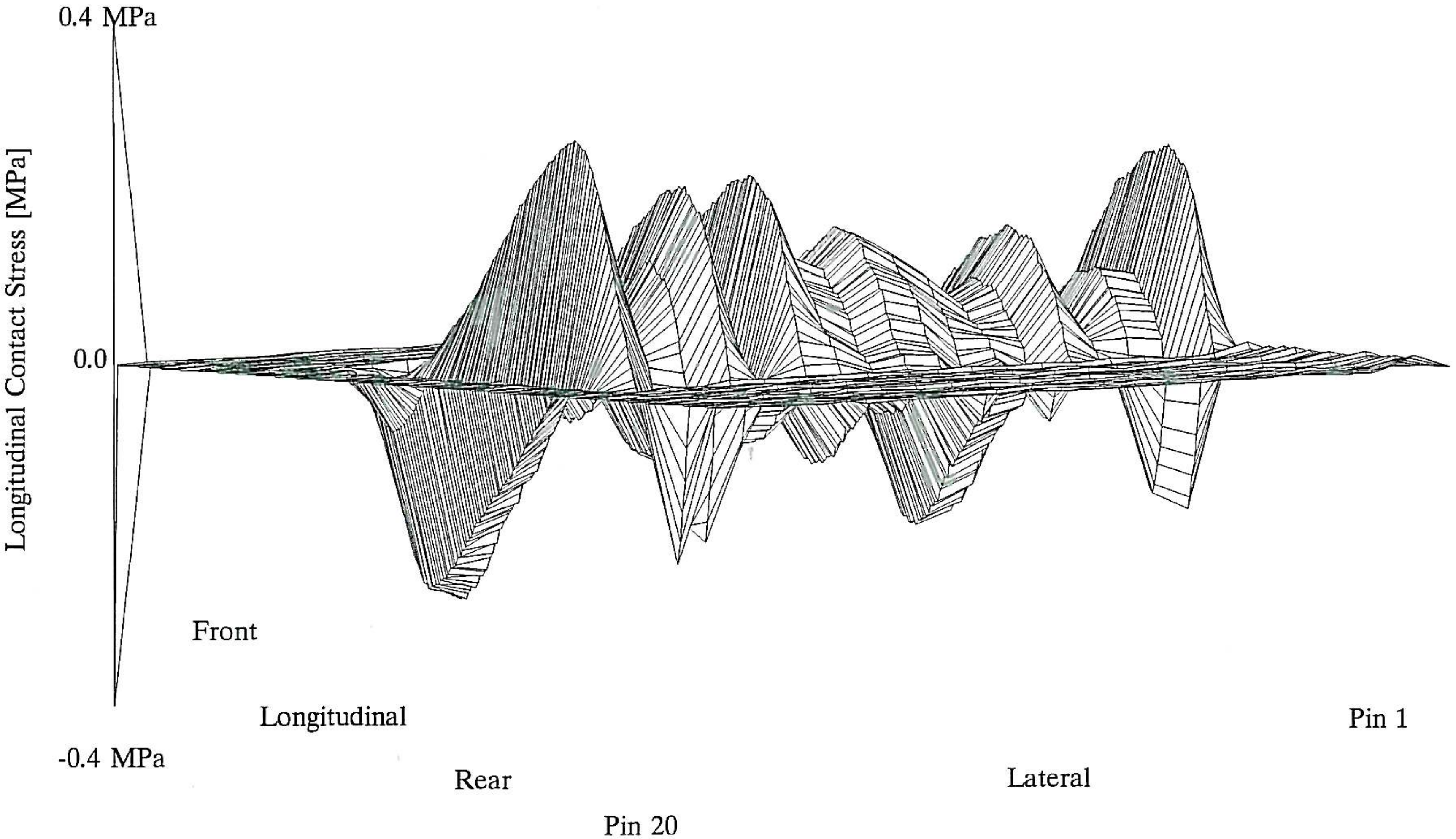
Used Bridgestone 425/65R22.5 R160AZ

FIGURE B15Y

Filename : nost91ay

Applied Vertical Load (HVS) = 100 kN
Measured Longitudinal Load = 1.275 kN
Max. Stress = 0.2859 MPa
Min. Stress = -0.2725 MPa

Inflation Press. = 950 kPa
Temperature = 22 deg.C
Wheel Speed = 2.777 m/s



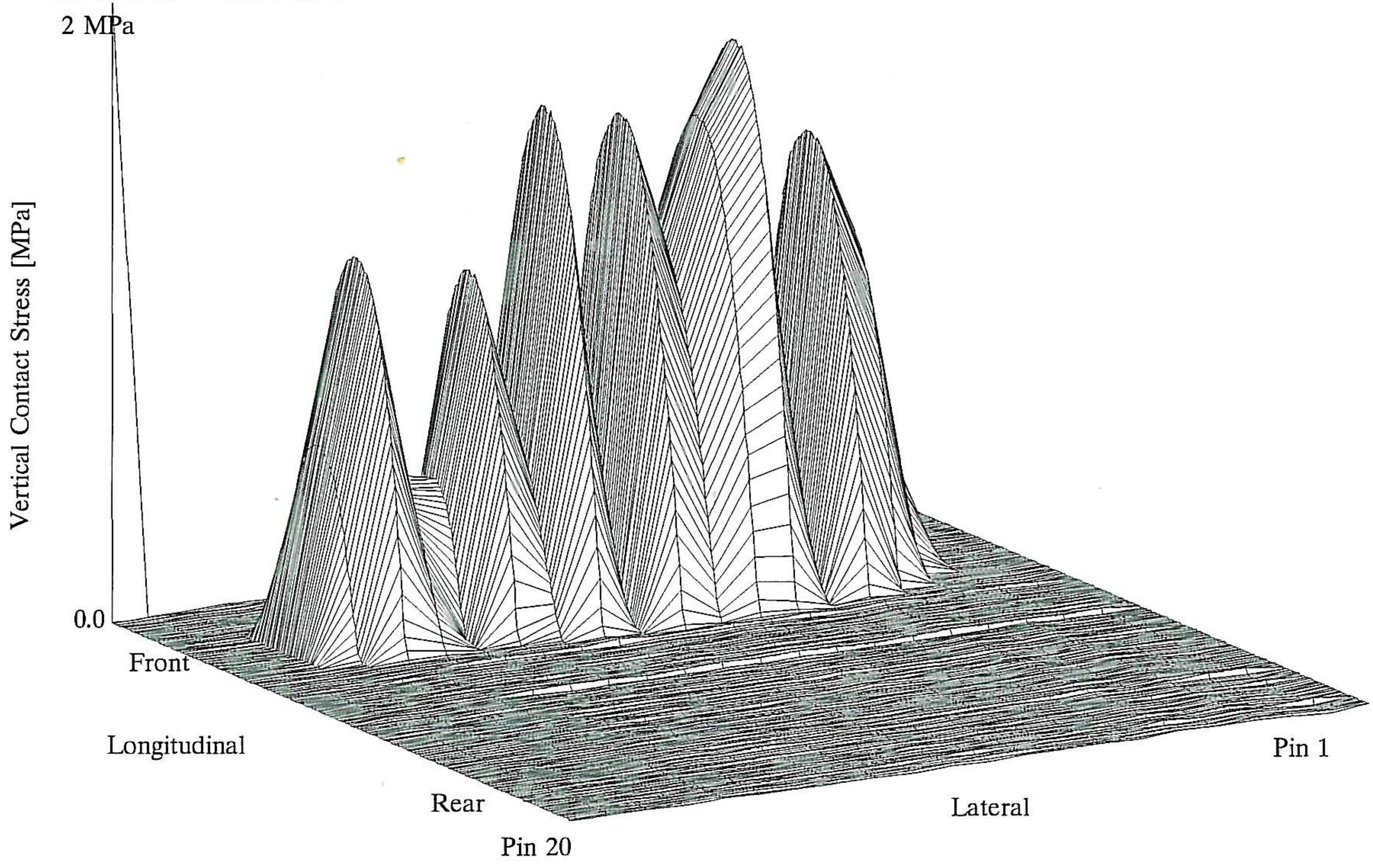
Used Bridgestone 425/65R22.5 R160AZ

FIGURE B15X

Filename : nost91ax

Applied Vertical Load (HVS) = 25 kN
Measured Vertical Load = 24.05 kN
Max. Stress = 1.765 MPa

Inflation Press. = 1100 kPa
Temperature = 20 deg.C
Wheel Speed = 3.321 m/s



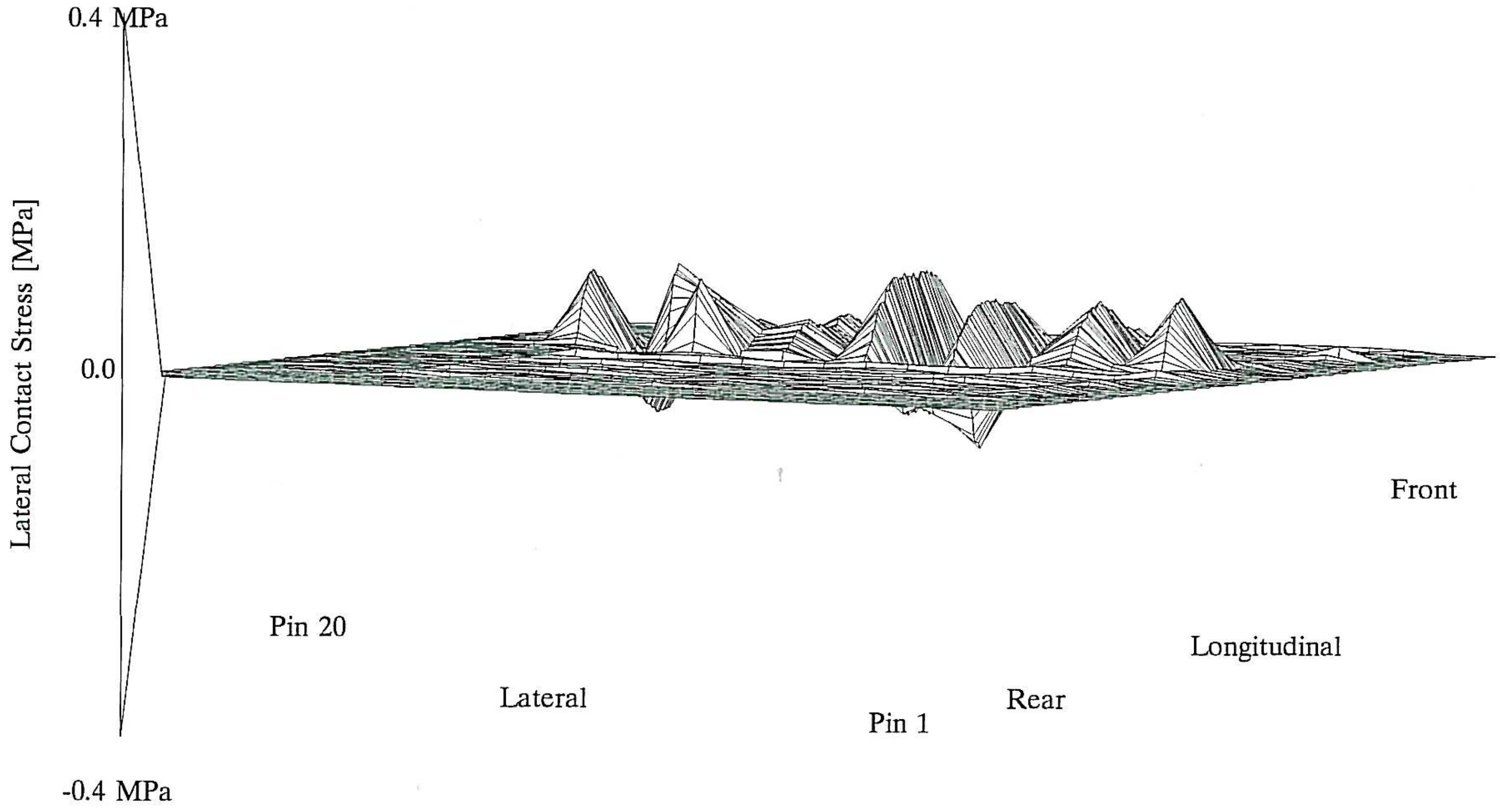
Used Bridgestone 425/65R22.5 R160AZ

Filename : nost12az

FIGURE B16Z

Applied Vertical Load (HVS) = 25 kN
Measured Lateral Load = 0.3899 kN
Max. Stress = 0.09897 MPa
Min. Stress = -0.08694 MPa

Inflation Press. = 1100 kPa
Temperature = 20 deg.C
Wheel Speed = 3.321 m/s



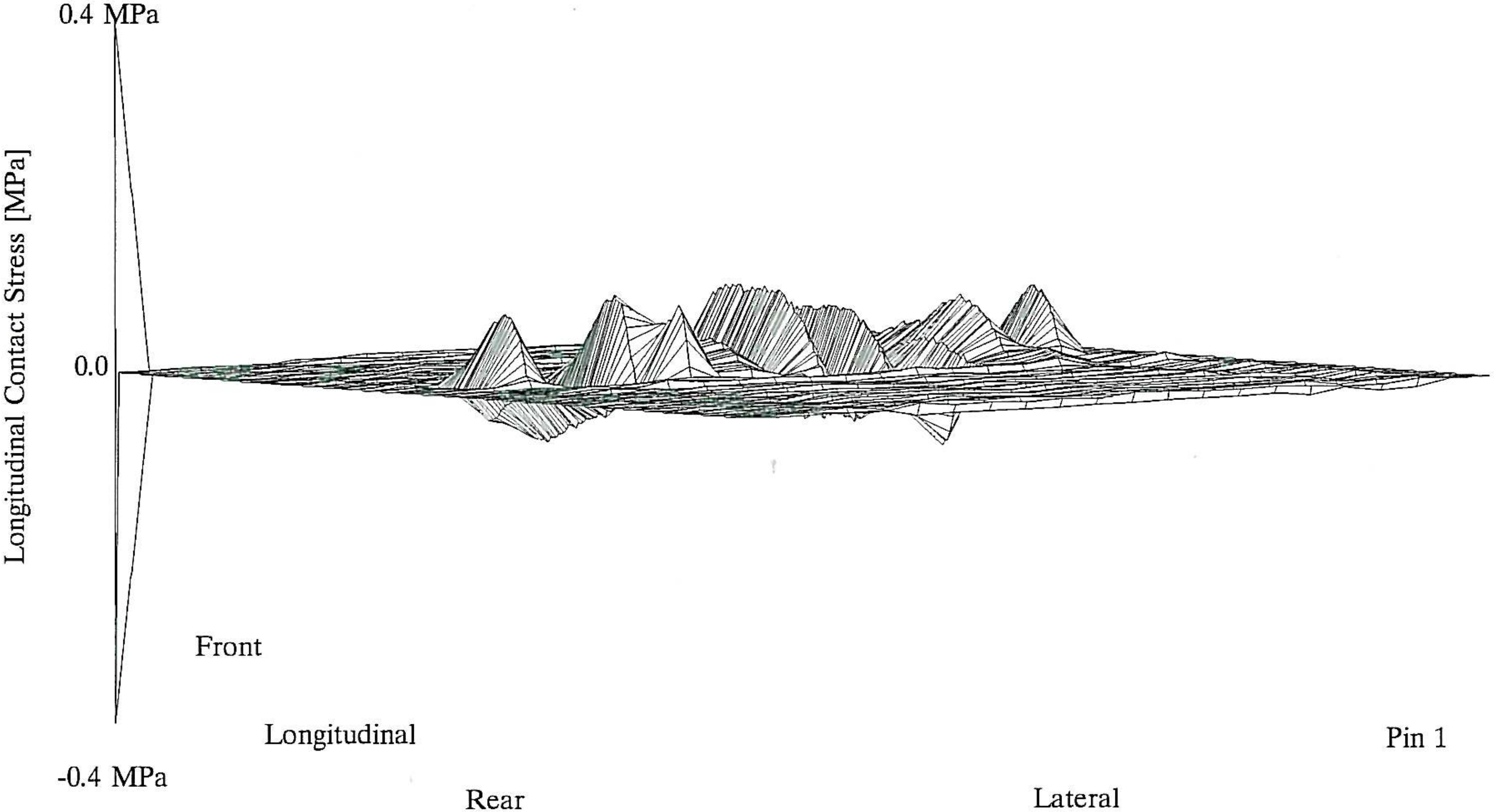
Used Bridgestone 425/65R22.5 R160AZ

FIGURE B16Y

Filename : nost12ay

Applied Vertical Load (HVS) = 25 kN
Measured Longitudinal Load = 0.394 kN
Max. Stress = 0.09897 MPa
Min. Stress = -0.08694 MPa

Inflation Press. = 1100 kPa
Temperature = 20 deg.C
Wheel Speed = 3.321 m/s



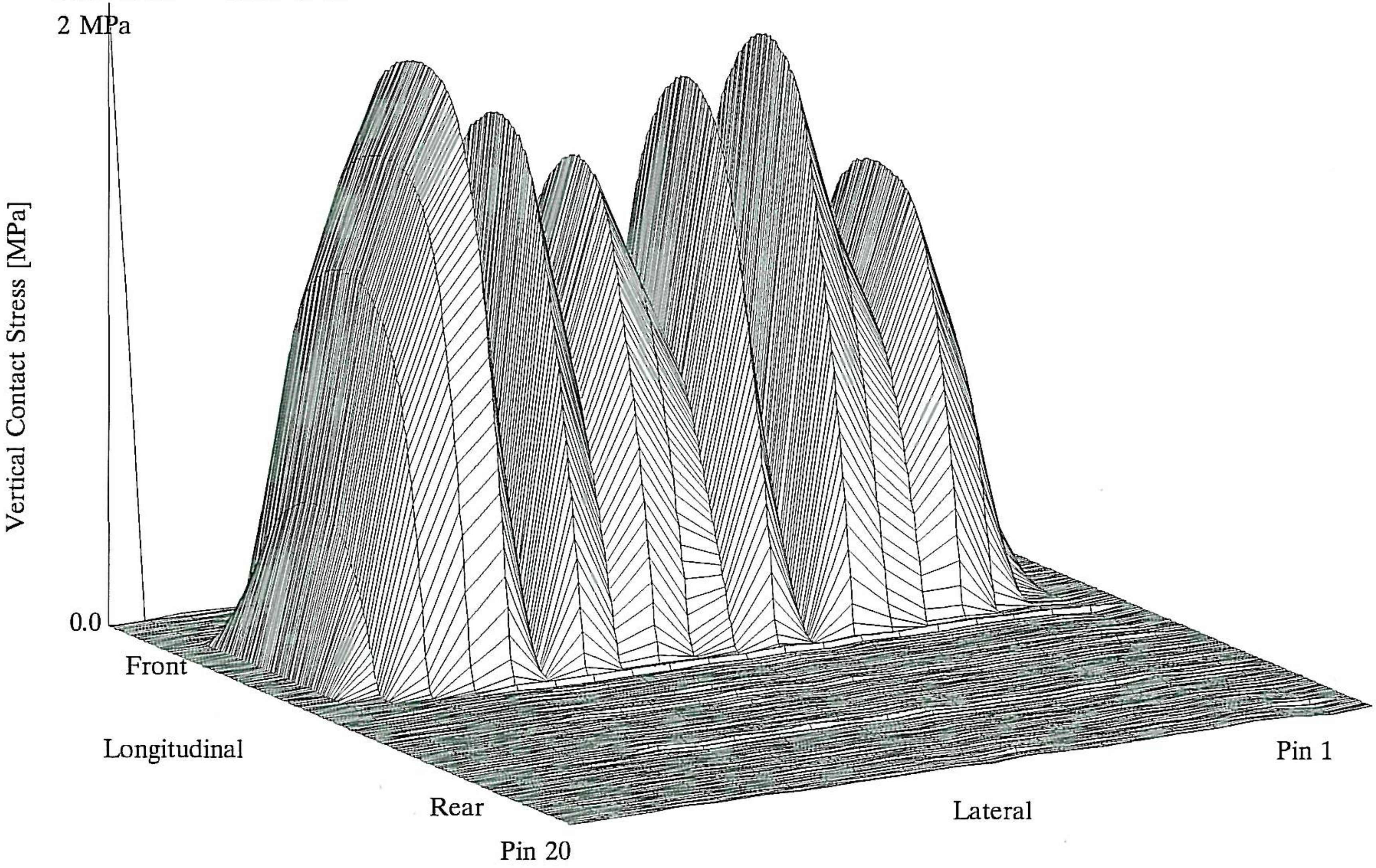
Used Bridgestone 425/65R22.5 R160AZ

FIGURE B16X

Filename : nost12ax

Applied Vertical Load (HVS) = 50 kN
Measured Vertical Load = 49.02 kN
Max. Stress = 1.889 MPa

Inflation Press. = 1100 kPa
Temperature = 20 deg.C
Wheel Speed = 3.009 m/s



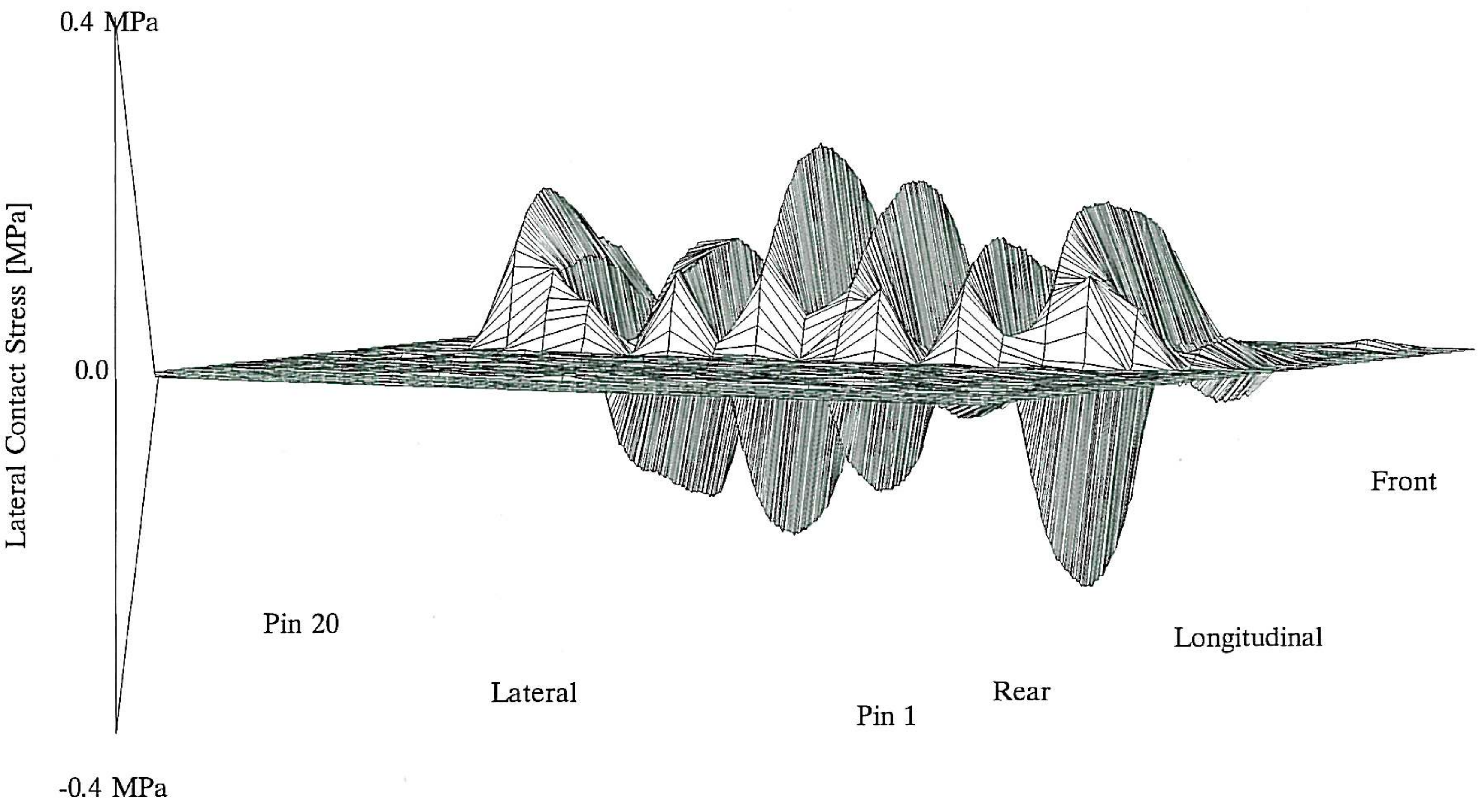
Used Bridgestone 425/65R22.5 R160AZ

Filename : nost15az

FIGURE B17Z

Applied Vertical Load (HVS) = 50 kN
Measured Lateral Load = 1.252 kN
Max. Stress = 0.2336 MPa
Min. Stress = -0.2569 MPa

Inflation Press. = 1100 kPa
Temperature = 20 deg.C
Wheel Speed = 3.009 m/s



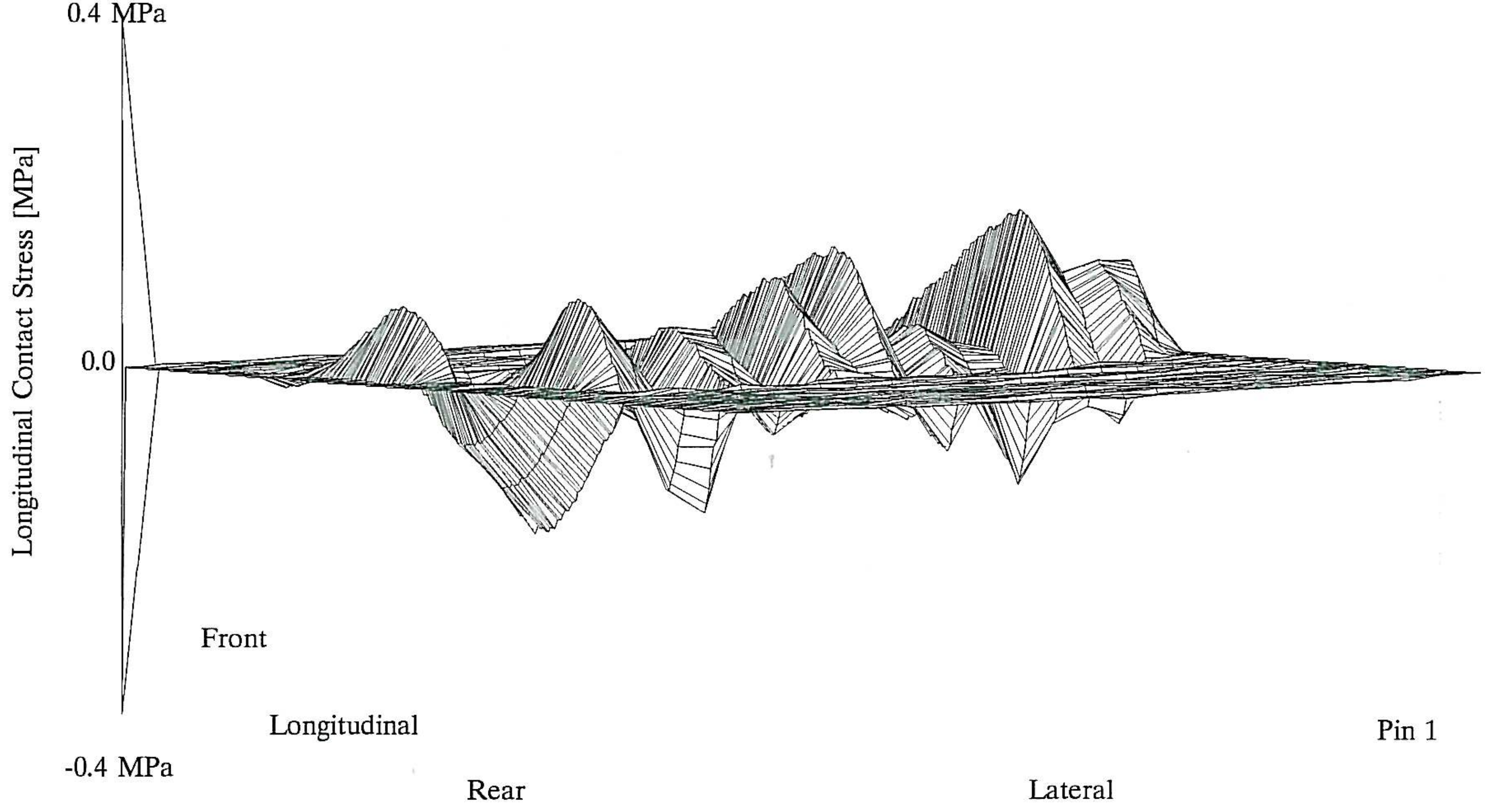
Used Bridgestone 425/65R22.5 R160AZ

FIGURE B17Y

Filename : nost15ay

Applied Vertical Load (HVS) = 50 kN
Measured Longitudinal Load = 0.2244 kN
Max. Stress = 0.1762 MPa
Min. Stress = -0.1826 MPa

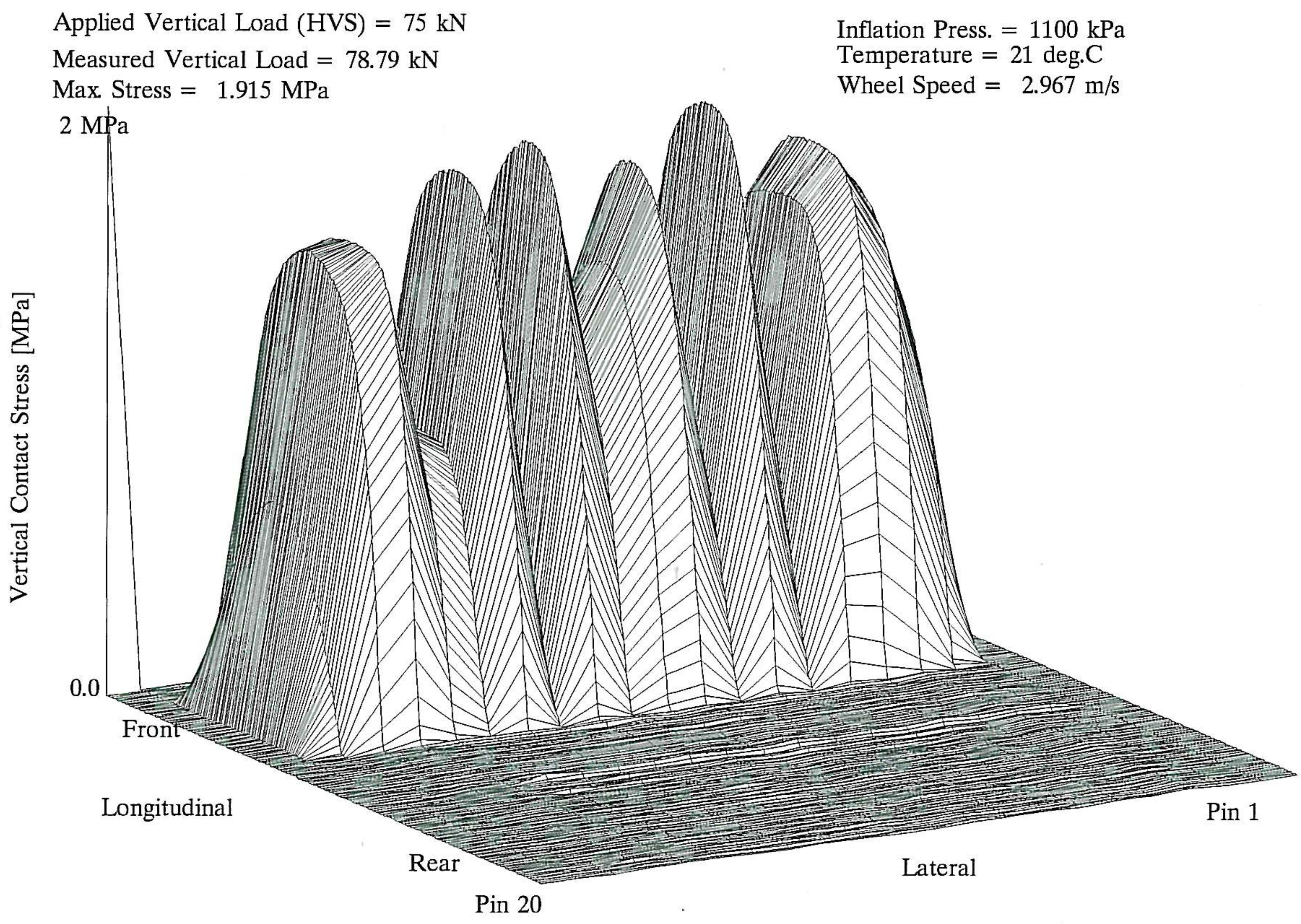
Inflation Press. = 1100 kPa
Temperature = 20 deg.C
Wheel Speed = 3.009 m/s



Used Bridgestone 425/65R22.5 R160AZ

Filename : nost15ax

FIGURE B17X



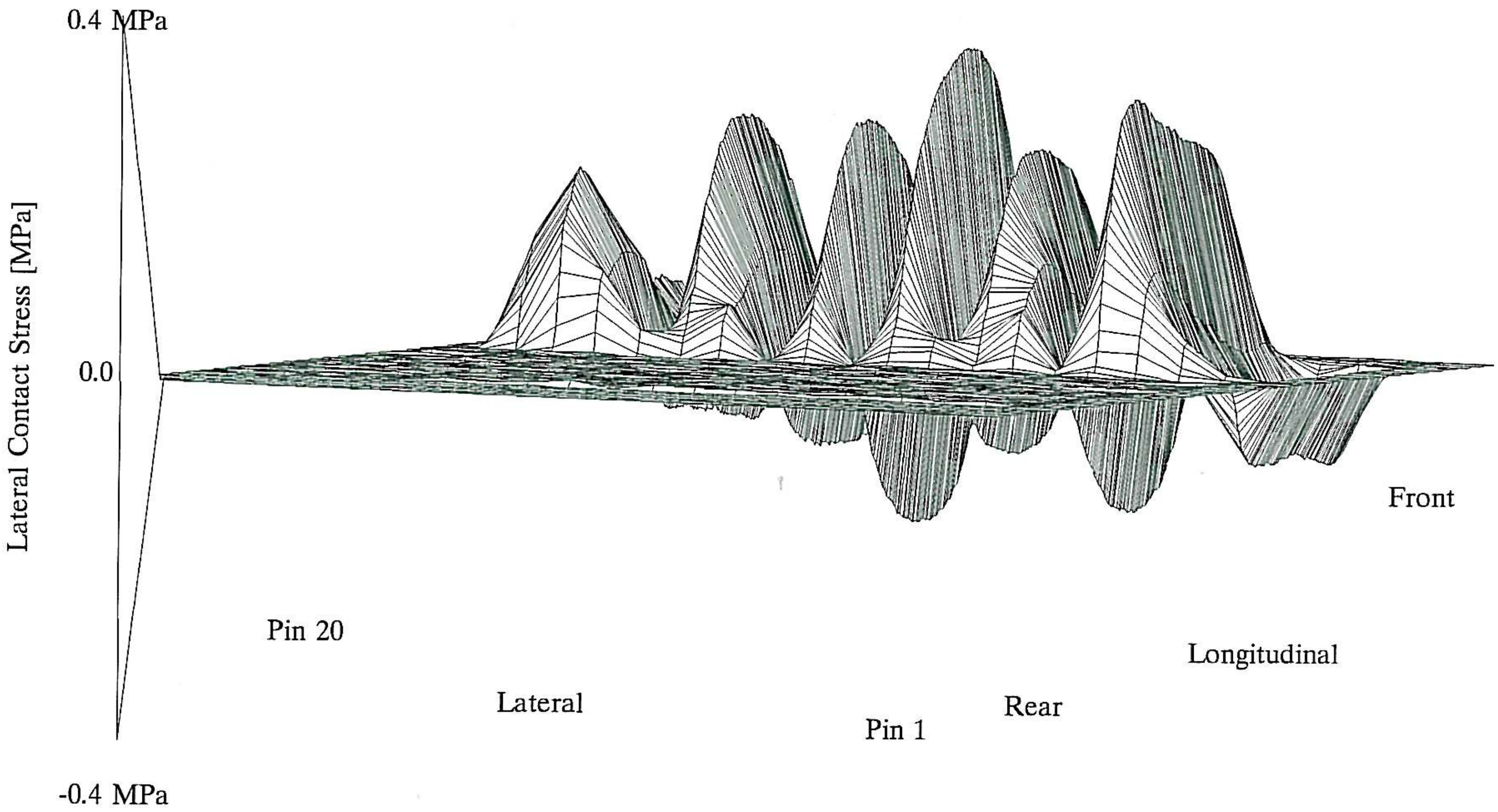
Used Bridgestone 425/65R22.5 R160AZ

Filename : nost17az

FIGURE B18Z

Applied Vertical Load (HVS) = 75 kN
Measured Lateral Load = 3.627 kN
Max. Stress = 0.3441 MPa
Min. Stress = -0.1813 MPa

Inflation Press. = 1100 kPa
Temperature = 21 deg.C
Wheel Speed = 2.967 m/s



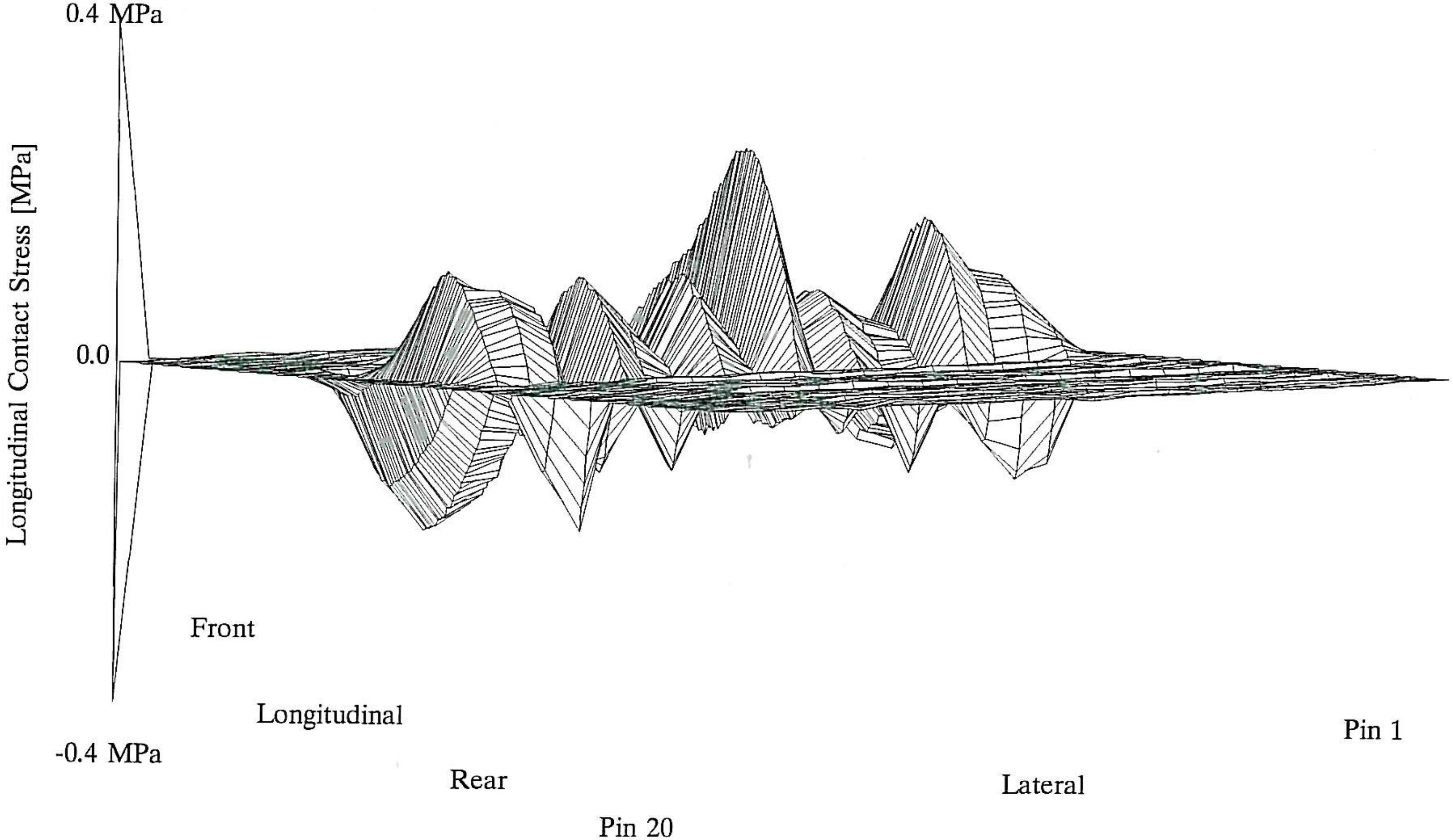
Filename : nost17ay

Used Bridgestone 425/65R22.5 R160AZ

FIGURE B18Y

Applied Vertical Load (HVS) = 75 kN
Measured Longitudinal Load = -0.4353 kN
Max. Stress = 0.2555 MPa
Min. Stress = -0.1903 MPa

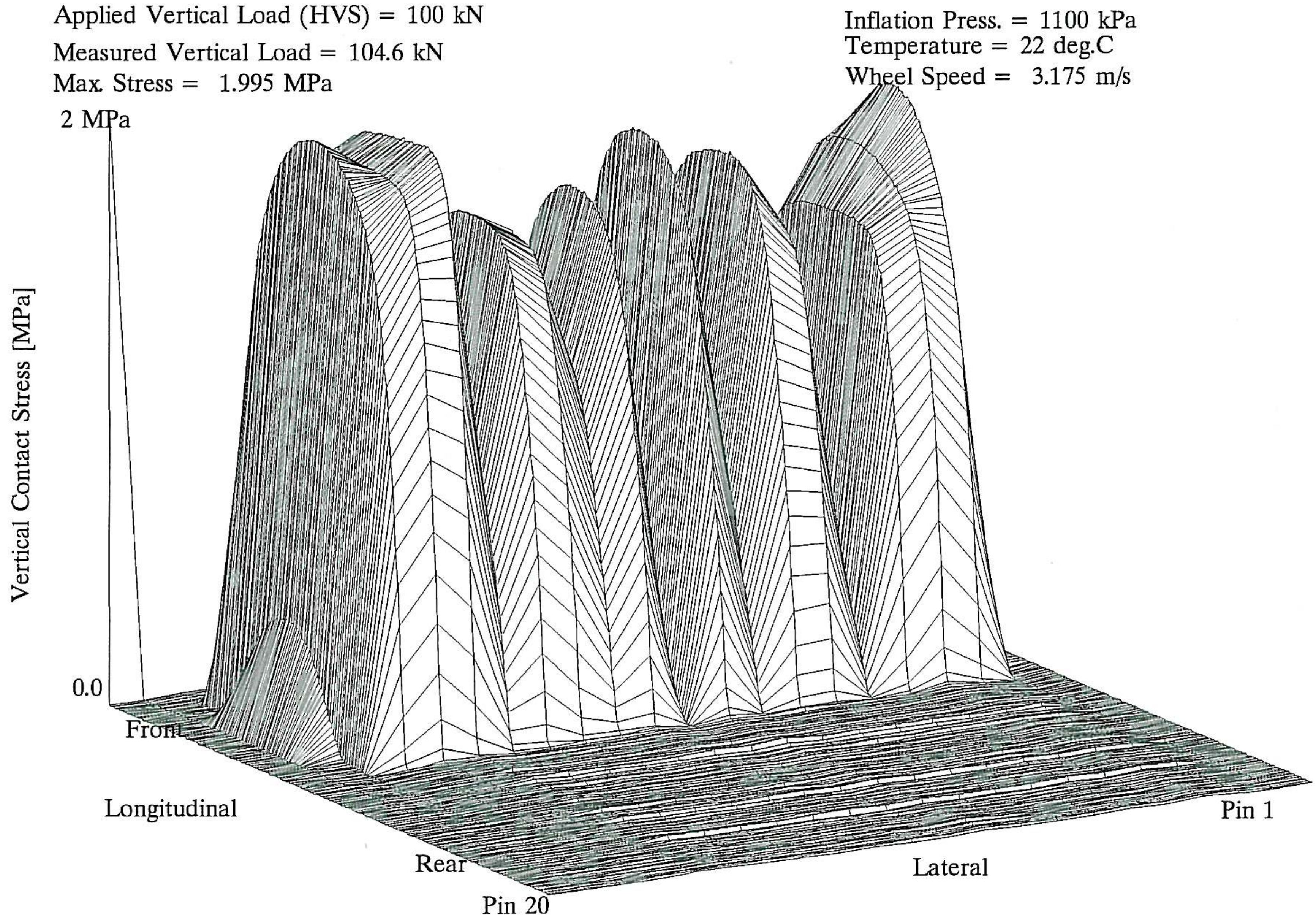
Inflation Press. = 1100 kPa
Temperature = 21 deg.C
Wheel Speed = 2.967 m/s



Used Bridgestone 425/65R22.5 R160AZ

Filename : nost17ax

FIGURE B18X



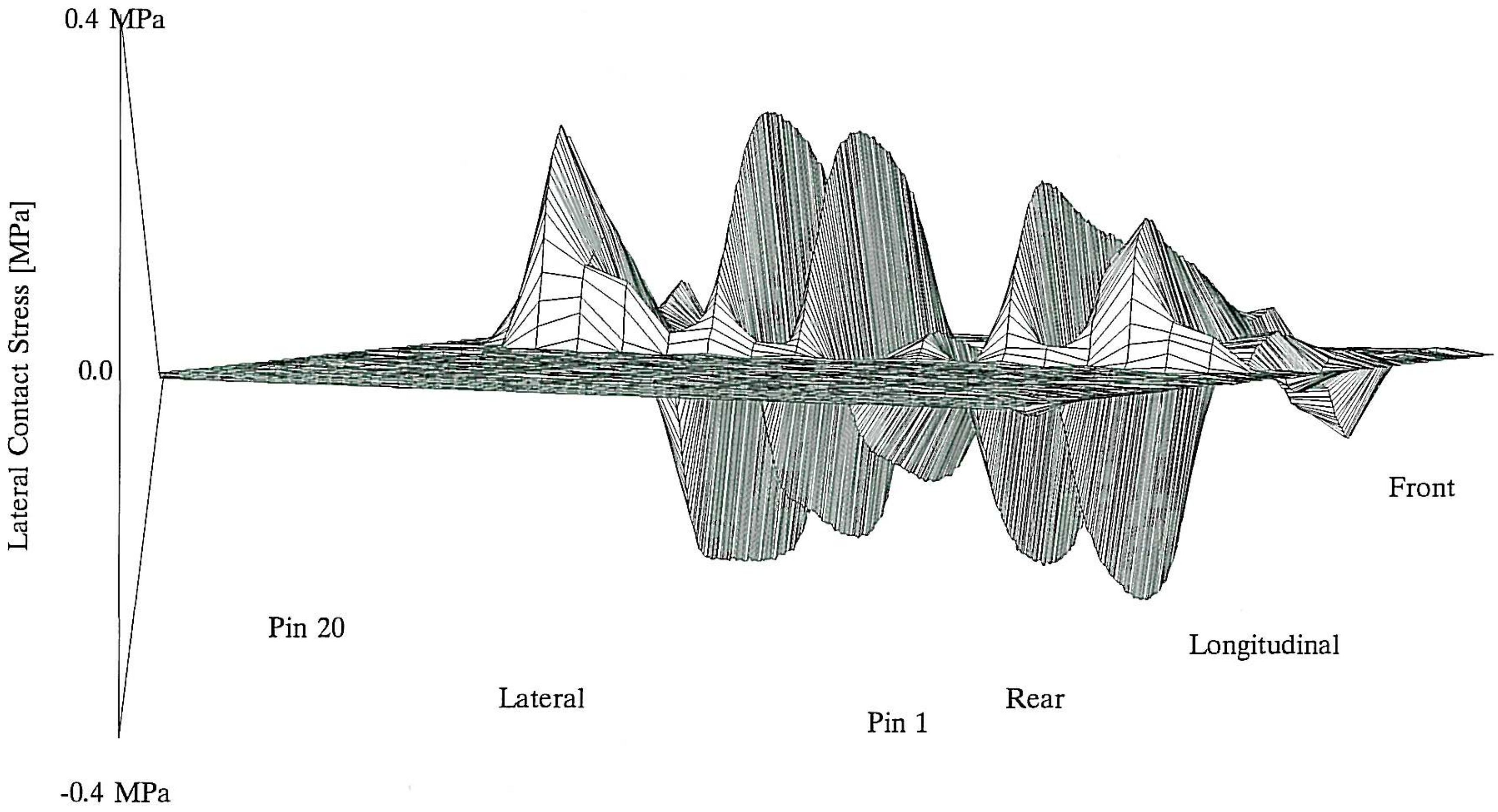
Used Bridgestone 425/65R22.5 R160AZ

Filename : nost11az

FIGURE B19Z

Applied Vertical Load (HVS) = 100 kN
Measured Lateral Load = -0.2554 kN
Max. Stress = 0.2622 MPa
Min. Stress = -0.2713 MPa

Inflation Press. = 1100 kPa
Temperature = 22 deg.C
Wheel Speed = 3.175 m/s



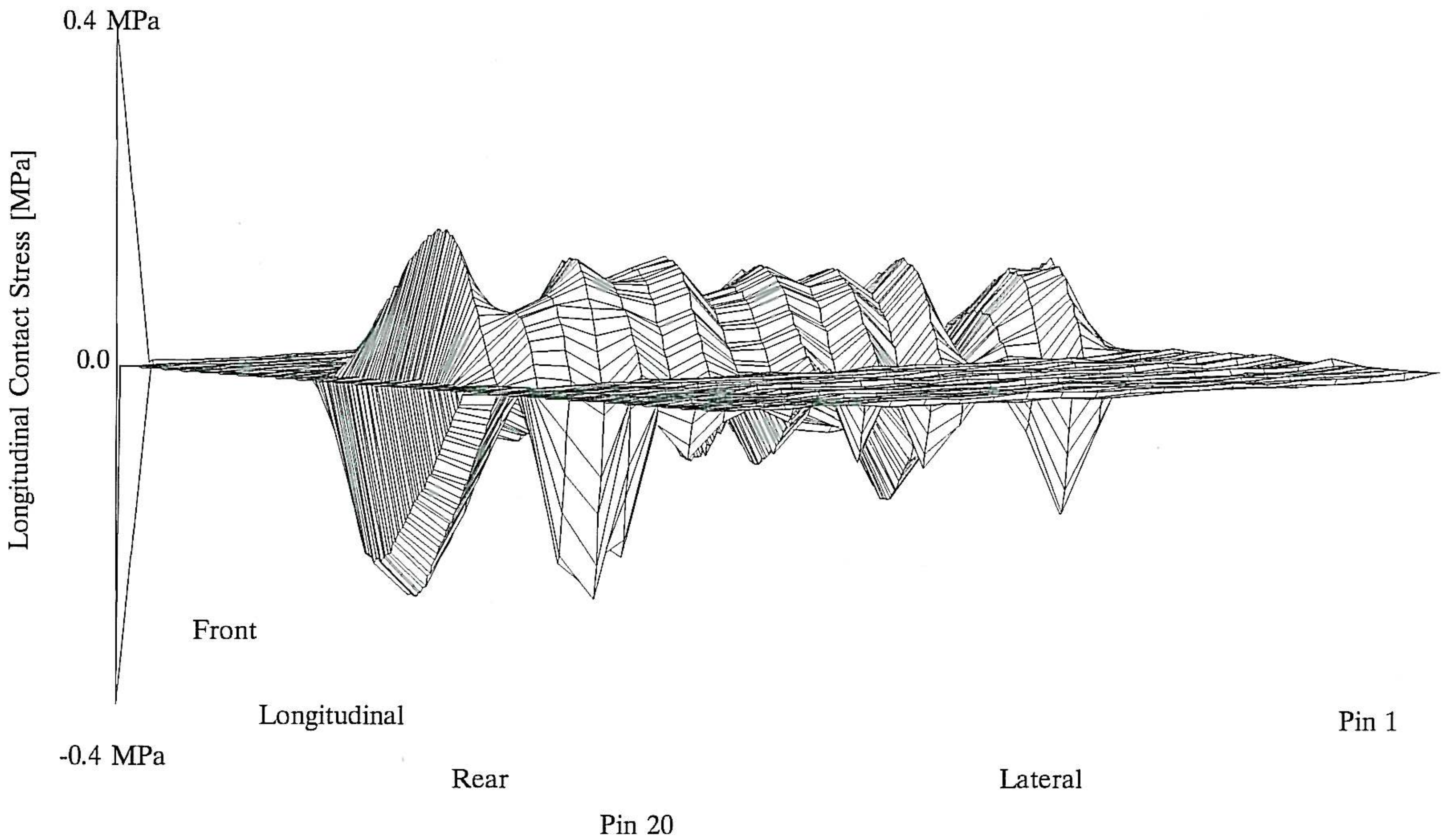
Used Bridgestone 425/65R22.5 R160AZ

FIGURE B19Y

Filename : nost11ay

Applied Vertical Load (HVS) = 100 kN
Measured Longitudinal Load = -1.036 kN
Max. Stress = 0.1816 MPa
Min. Stress = -0.2679 MPa

Inflation Press. = 1100 kPa
Temperature = 22 deg.C
Wheel Speed = 3.175 m/s



Used Bridgestone 425/65R22.5 R160AZ

Filename : nost11ax

FIGURE B19X

APPENDIX C:

3-DIMENSIONAL (3-D) PLOTS OF STRESSES MEASURED UNDER THE LINTRACK *USED* BRIDGESTONE 425/65 R 22.5 R160AZ TYRE AT "CREEP SPEED", SPECIAL CONDITIONS

TABLE 1 (Cont.): HVS4: 3D Stress Sensor Tests on the used(old) Bridgestone R160AZ 425/65 R22.5 PR20 tyre

Legend of filename with tests on OLD (used) tyre : NOSC92AZ.PRN : **SPECIAL TESTS**

N=Netherlands ; O=Lintrack (Old or used tyre) ; S=Super single ; C=Creep speed;(or T=Traffic (HVS) speed) ;

9=Cold inflation pressure 950 kPa ; 2=Vertical load 25 kN : A=Test (repeat)1 (or B=repeat 2 or C=repeat 3);

Z=Vertical stress (or X=Transverse, or Y=Longitudinal).

DATE 10/06/96

Speed distance 1.0m

NETOLD.WK1

HVS POSITION

Traffic side

Traffic side | Cabin end

Caravan side

Filename *.prn		PRESSURE (kPa)	HVS (kN)	LOAD Box (kN)	TEMP °C	SPEED (m/s)	Hz (sam/sec)	Figure no.	Pin numbers across loadcell 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20 (A = ALL DIRECTIONS MISSED THE PIN)	3d-Loadcell Total load (kN)	COMMENTS **
NOSC97D	z/x/y	950	75	72.5	16	0.31	150	C1	A												G	G	G					A	77.96	POINT 2
NOSC97E	z/x/y	950	75	72.5	16	0.31	150	-	A												G	G	G					A	76.08	POINT 2
NOSC97F	z/x/y	950	75	72.5	16	0.31	150	-	A												G	G	G					A	75.80	POINT 2
NOSC97G	z/x/y	950	75	74.4	16	0.31	150	-	A																			A	74.51	POINT 4
NOSC97H	z/x/y	950	75	74.4	16	0.31	150	C3	A																			A	74.36	POINT 4
NOSC97I	z/x/y	950	75	74.4	16	0.31	150	-	A																			A	74.49	POINT 4
NOSC97J	z/x/y	950	75	74.2	16	0.31	150	C4	A					G		G	G	G	G	G	G	G	G					A	66.86	POINT 5
NOSC97K	z/x/y	950	75	74.2	16	0.31	150	-	A					G		G	G	G	G	G	G	G	G					A	65.80	POINT 5
NOSC97L	z/x/y	950	75	74.0	16	0.31	150	-	A					G		G	G	G	G	G	G	G	G					A	65.65	POINT 5
NOSC97M	z/x/y	950	75	73.8	16	0.31	150	-																				A	79.95	POINT 3
NOSC97N	z/x/y	950	75	73.0	16	0.31	150	-																				A	80.35	POINT 3
NOSC97O	z/x/y	950	75	73.5	16	0.31	150	C2																				A	79.92	POINT 3
NOSC97P	z/x/y	950	75	73.6	16	0.31	150	C5	A																			A	73.32	MOVED 5mm (PT1)
NOSC97Q	z/x/y	950	75	73.6	16	0.31	150	-	A																			A	73.17	MOVED 5mm (PT1)
NOSC97R	z/x/y	950	75	73.4	16	0.31	150	-	A																			A	73.02	MOVED 5mm (PT1)
NOSC97S	z/x/y	950	75	73.6	16	0.31	150	-	A																			A	80.16	MOVED 10mm (PT1)
NOSC97T	z/x/y	950	75	73.6	16	0.31	150	C6	A																			A	79.53	MOVED 10mm (PT1)
NOSC97U	z/x/y	950	75	73.5	16	0.31	150	-	A																			A	78.58	MOVED 10mm (PT1)
NOSC97V	z/x/y	950	75	73.5	16	0.31	150	-	A																				78.65	MOVED 15mm (PT1)
NOSC97W	z/x/y	950	75	73.5	16	0.31	150	-	A																				78.09	MOVED 15mm (PT1)
NOSC97X	z/x/y	950	75	73.5	16	0.31	150	C7	A																				78.43	MOVED 15mm (PT1)
NOLC97A	z/x/y	950	75	74.5	16	0.31	150	-	A																				77.40	TILT 2%
NOLC97B	z/x/y	950	75	74.5	16	0.31	150	C8	A																				77.54	TILT 2%
NOLC97C	z/x/y	950	75	73.6	16	0.31	150	-	A																				75.07	TILT 2%
NOLC97D	z/x/y	950	75	73.6	16	0.31	150	-	A																			A	81.12	TILT 3%
NOLC97E	z/x/y	950	75	73.6	16	0.31	150	-	A																			A	75.60	TILT 3%
NOLC97F	z/x/y	950	75	73.3	16	0.31	150	C9	A																			A	78.66	TILT 3%

** PT1 =POINT 1

* G = WORN SECTION ON TYRE

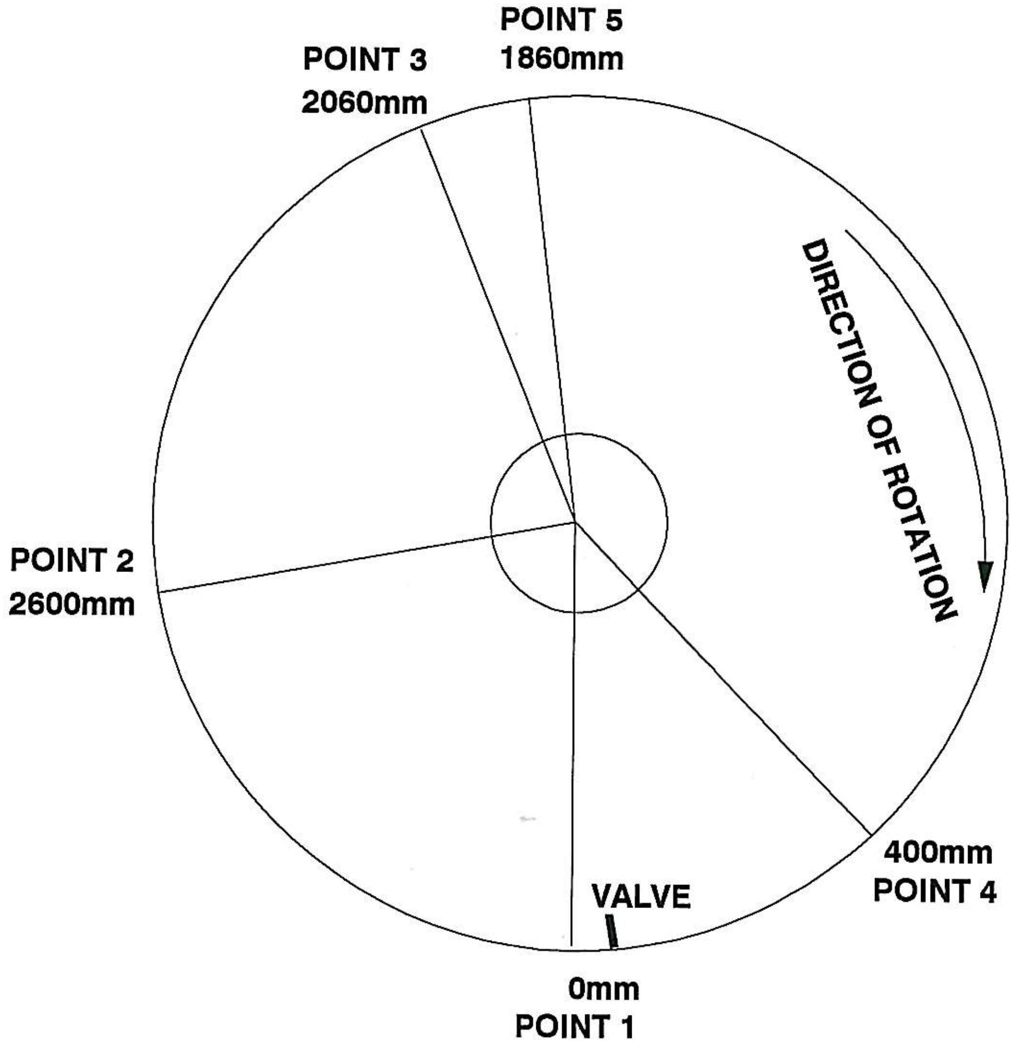


FIGURE C1
CIRCUMFERAL TEST POSITIONS AROUND THE TYRE
USED BRIDGESTONE TYRE (160AZ)
(SPECIAL TESTS)

WHEELD.DRW

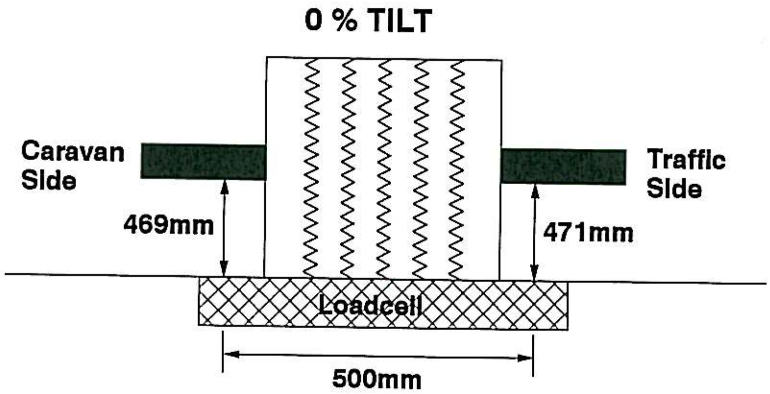


FIGURE C2

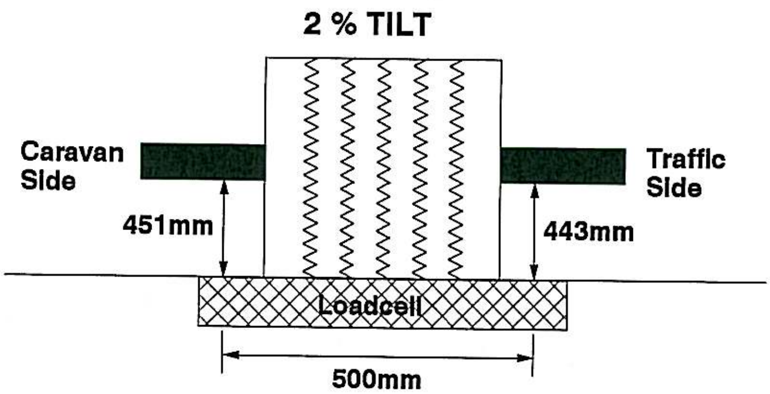


FIGURE C3

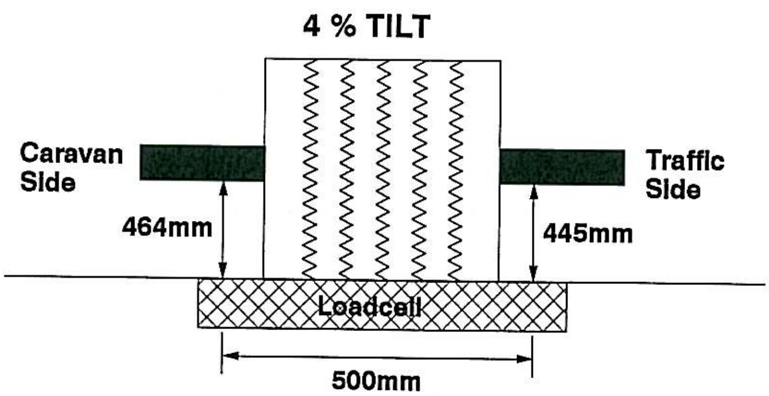


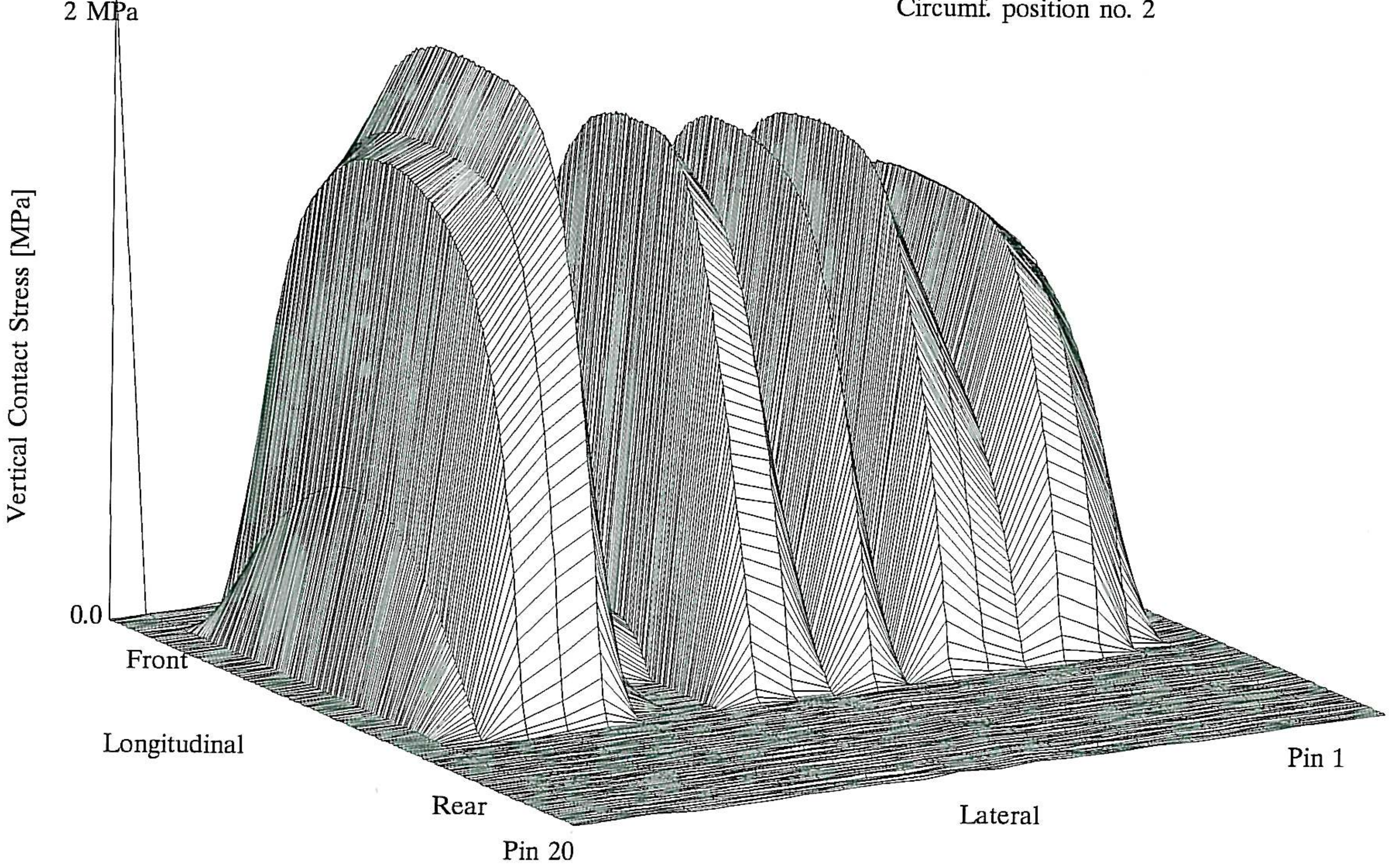
FIGURE C4

WHEEL-3D.DRW

AXLE HEIGHTS TO VRSPTA SURFACE IN TILTING OF THE HVS USED BRIDGESTONE TYRE (160AZ) (SPECIAL TESTS)

Applied Vertical Load (HVS) = 75 kN
Measured Vertical Load = 77.92 kN
Max. Stress = 1.92 MPa

Inflation Press. = 950 kPa
Temperature = 21 deg.C
Wheel Speed = 0.31 m/s
Circumf. position no. 2



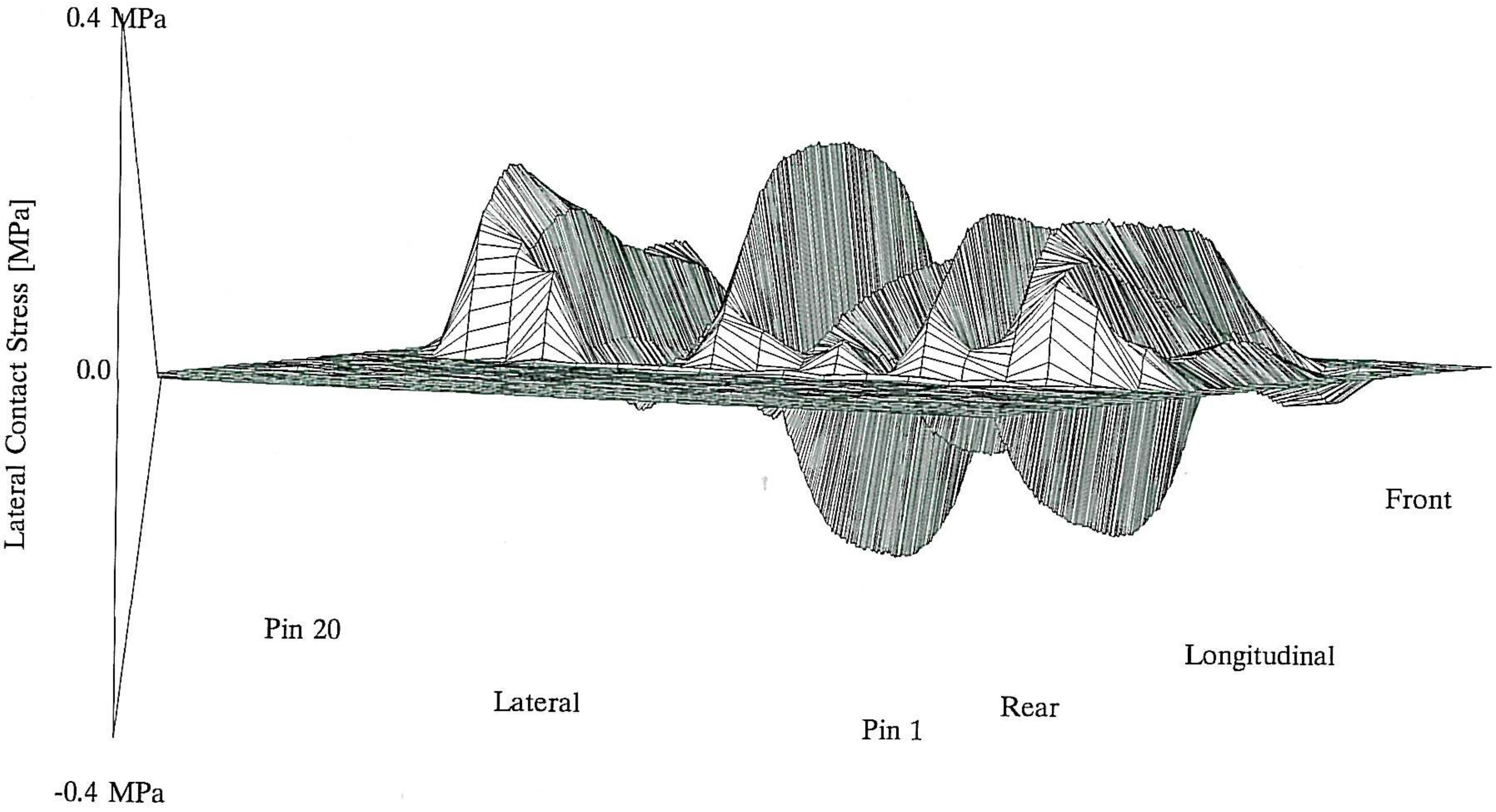
Used Bridgestone 425/65R22.5 R160AZ

FIGURE C1Z

Filename : nosc97dz

Applied Vertical Load (HVS) = 75 kN
Measured Lateral Load = 2.82 kN
Max. Stress = 0.2433 MPa
Min. Stress = -0.2195 MPa

Inflation Press. = 950 kPa
Temperature = 21 deg.C
Wheel Speed = 0.31 m/s
Circumf. position no. 2



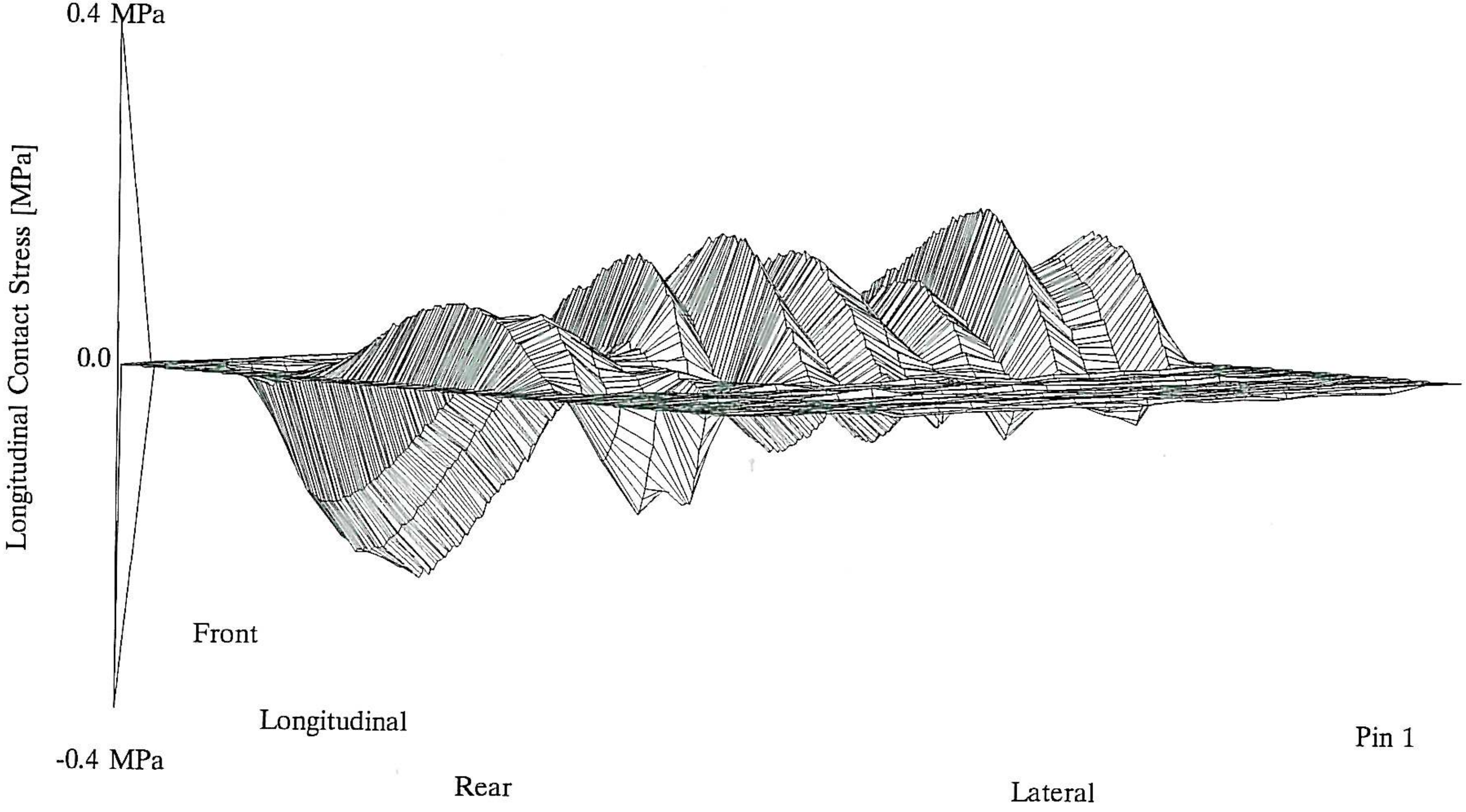
Filename : nosc97dy

Used Bridgestone 425/65R22.5 R160AZ

FIGURE C1Y

Applied Vertical Load (HVS) = 75 kN
Measured Longitudinal Load = 0.2327 kN
Max. Stress = 0.1844 MPa
Min. Stress = -0.2462 MPa

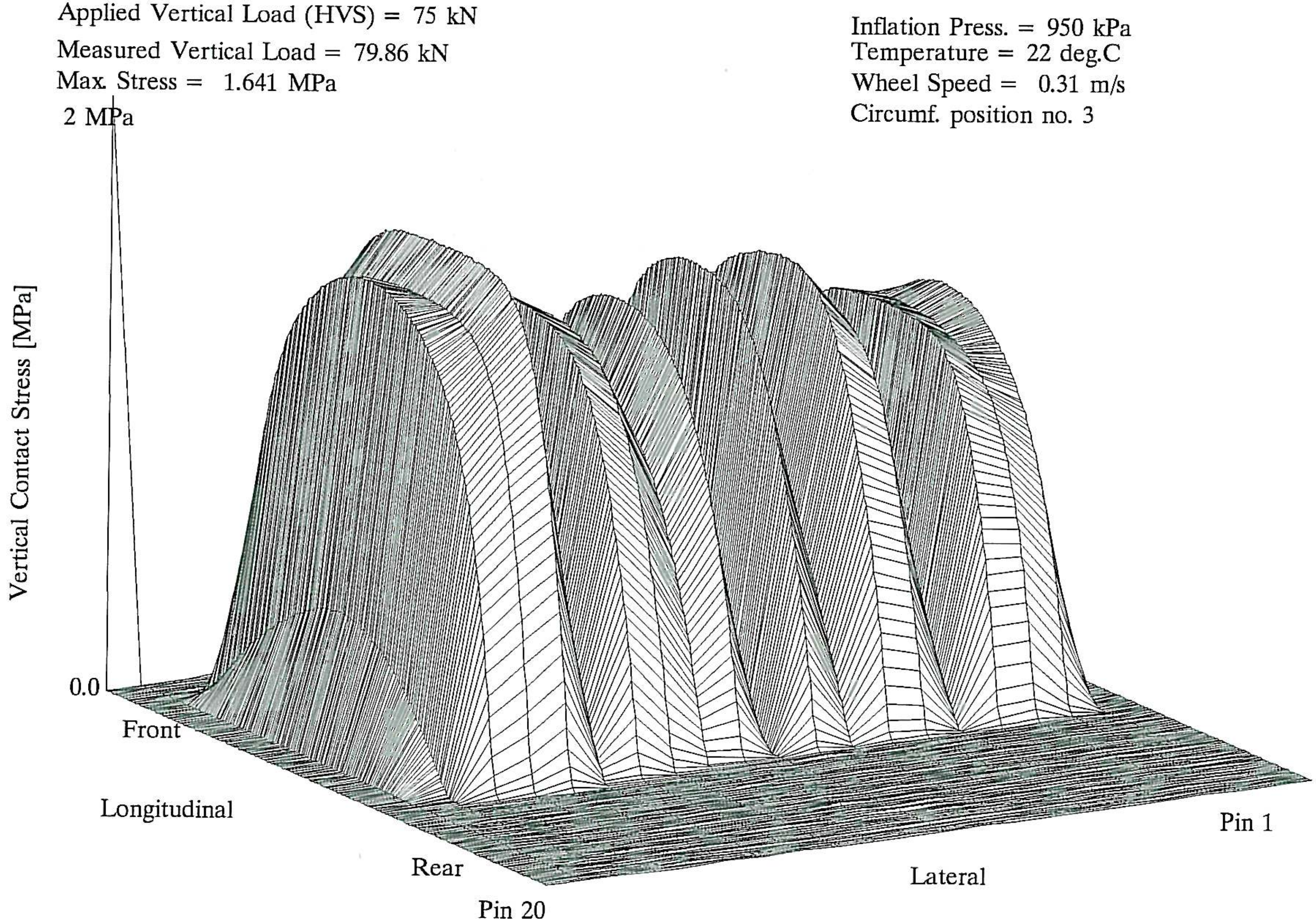
Inflation Press. = 950 kPa
Temperature = 21 deg.C
Wheel Speed = 0.31 m/s
Circumf. position no. 2



Used Bridgestone 425/65R22.5 R160AZ

Filename : nosc97dx

FIGURE C1X



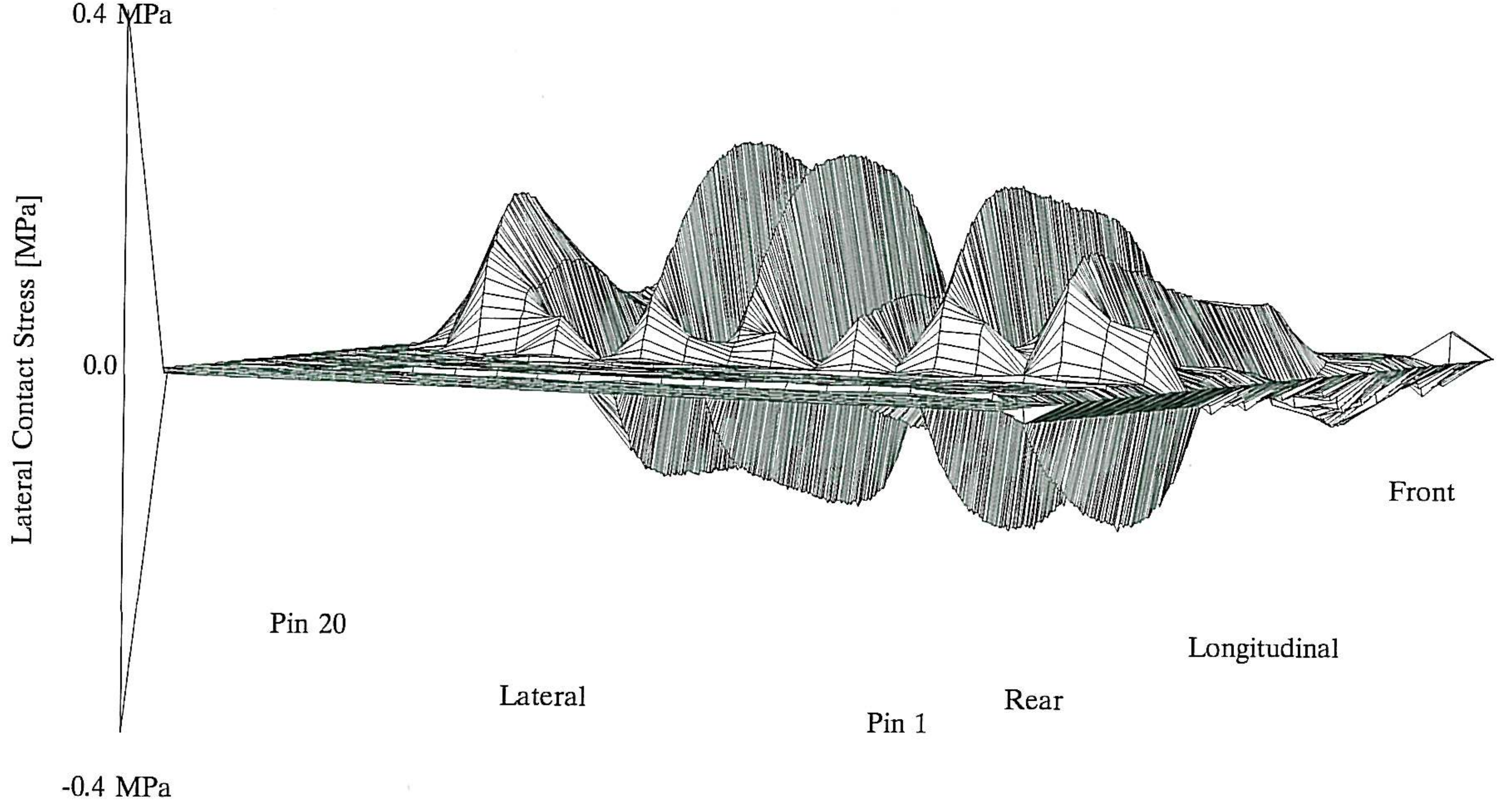
Used Bridgestone 425/65R22.5 R160AZ

FIGURE C2Z

Filename : nosc97oz

Applied Vertical Load (HVS) = 75 kN
Measured Lateral Load = 1.033 kN
Max. Stress = 0.2323 MPa
Min. Stress = -0.1906 MPa

Inflation Press. = 950 kPa
Temperature = 22 deg.C
Wheel Speed = 0.31 m/s
Circumf. position no. 3



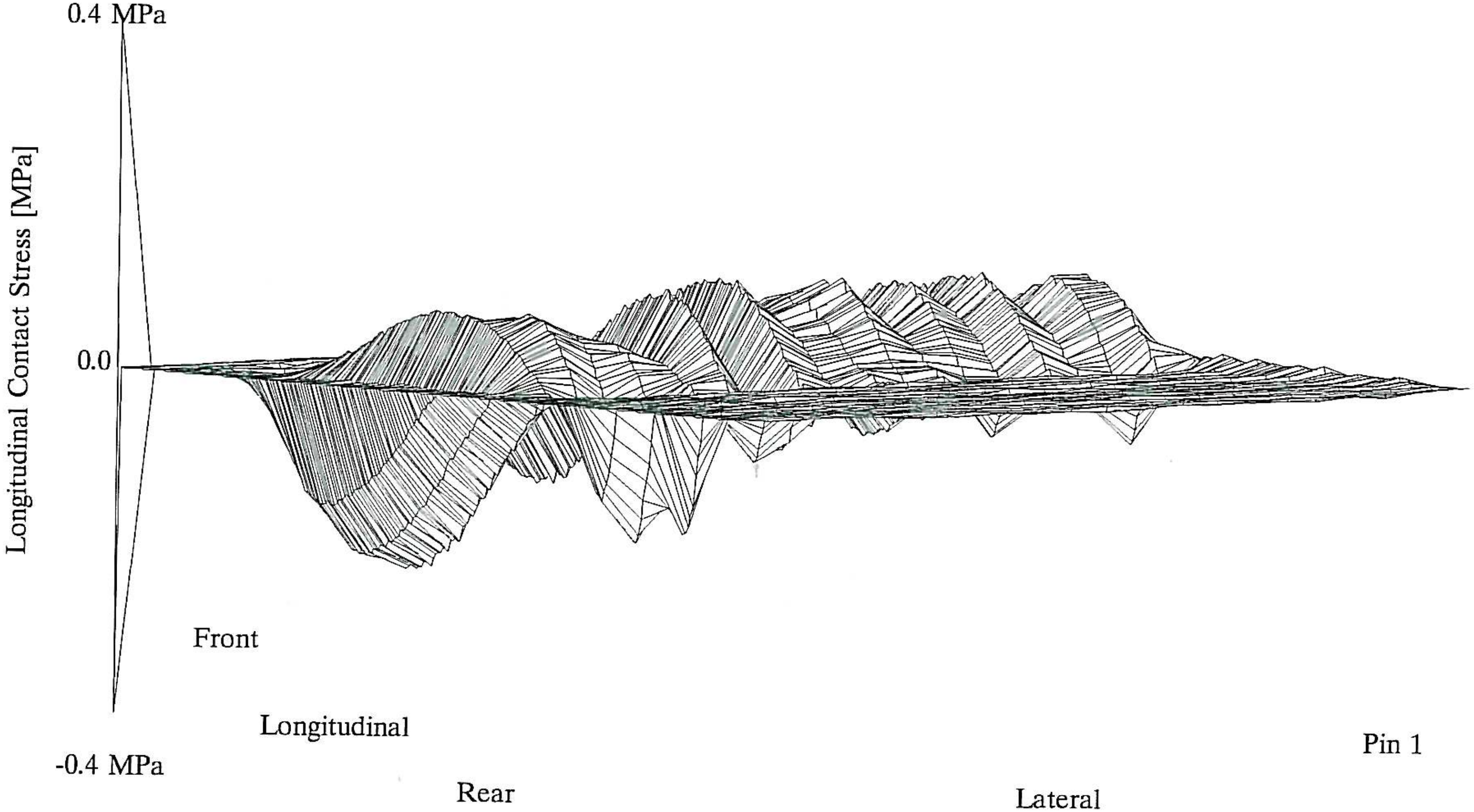
Filename : nosc97oy

Used Bridgestone 425/65R22.5 R160AZ

FIGURE C2Y

Applied Vertical Load (HVS) = 75 kN
Measured Longitudinal Load = -0.292 kN
Max. Stress = 0.1163 MPa
Min. Stress = -0.2309 MPa

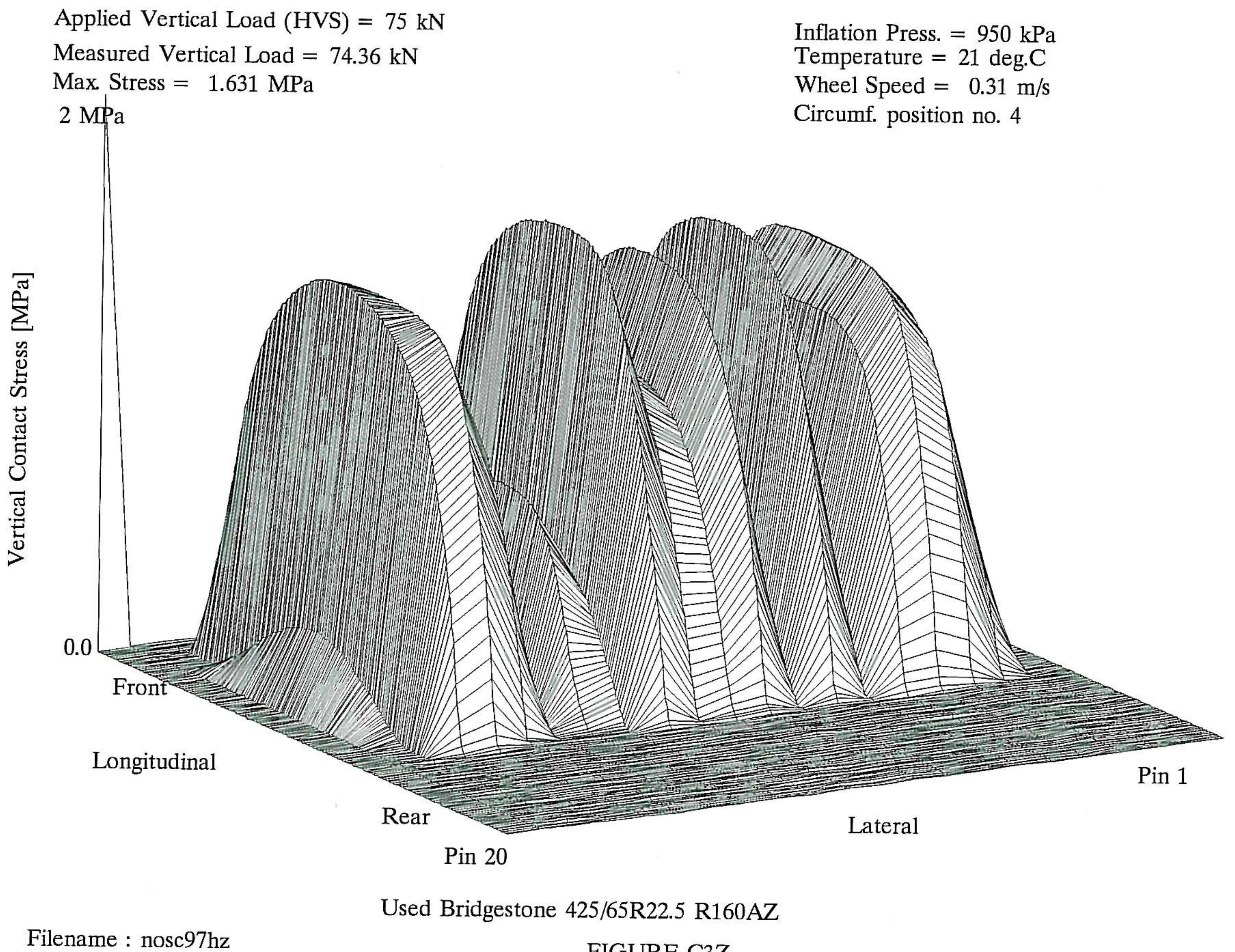
Inflation Press. = 950 kPa
Temperature = 22 deg.C
Wheel Speed = 0.31 m/s
Circumf. position no. 3



Used Bridgestone 425/65R22.5 R160AZ

Filename : nosc97ox

FIGURE C2X

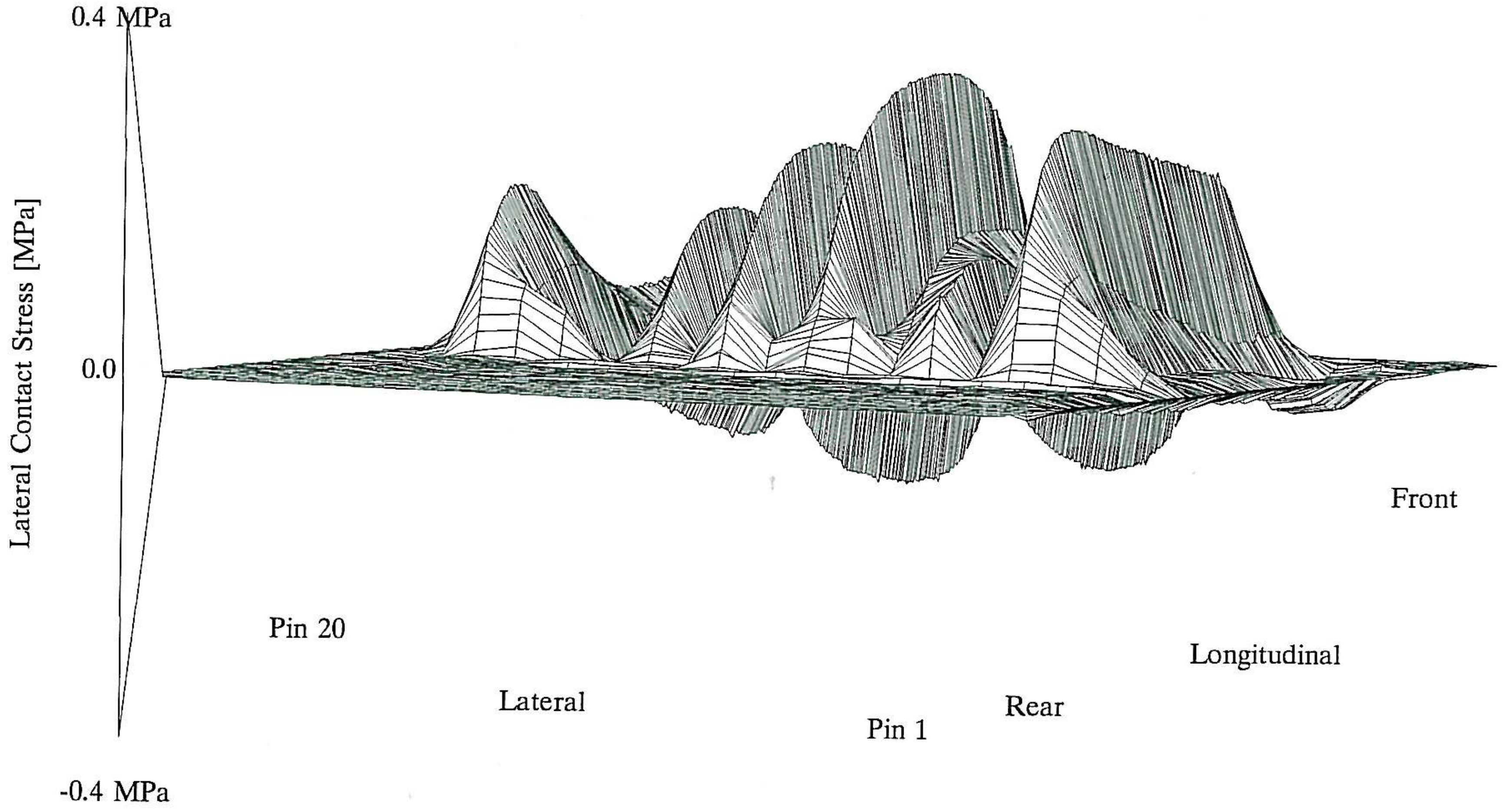


Used Bridgestone 425/65R22.5 R160AZ

FIGURE C3Z

Applied Vertical Load (HVS) = 75 kN
Measured Lateral Load = 4.487 kN
Max. Stress = 0.319 MPa
Min. Stress = -0.139 MPa

Inflation Press. = 950 kPa
Temperature = 21 deg.C
Wheel Speed = 0.31 m/s
Circumf. position no. 4



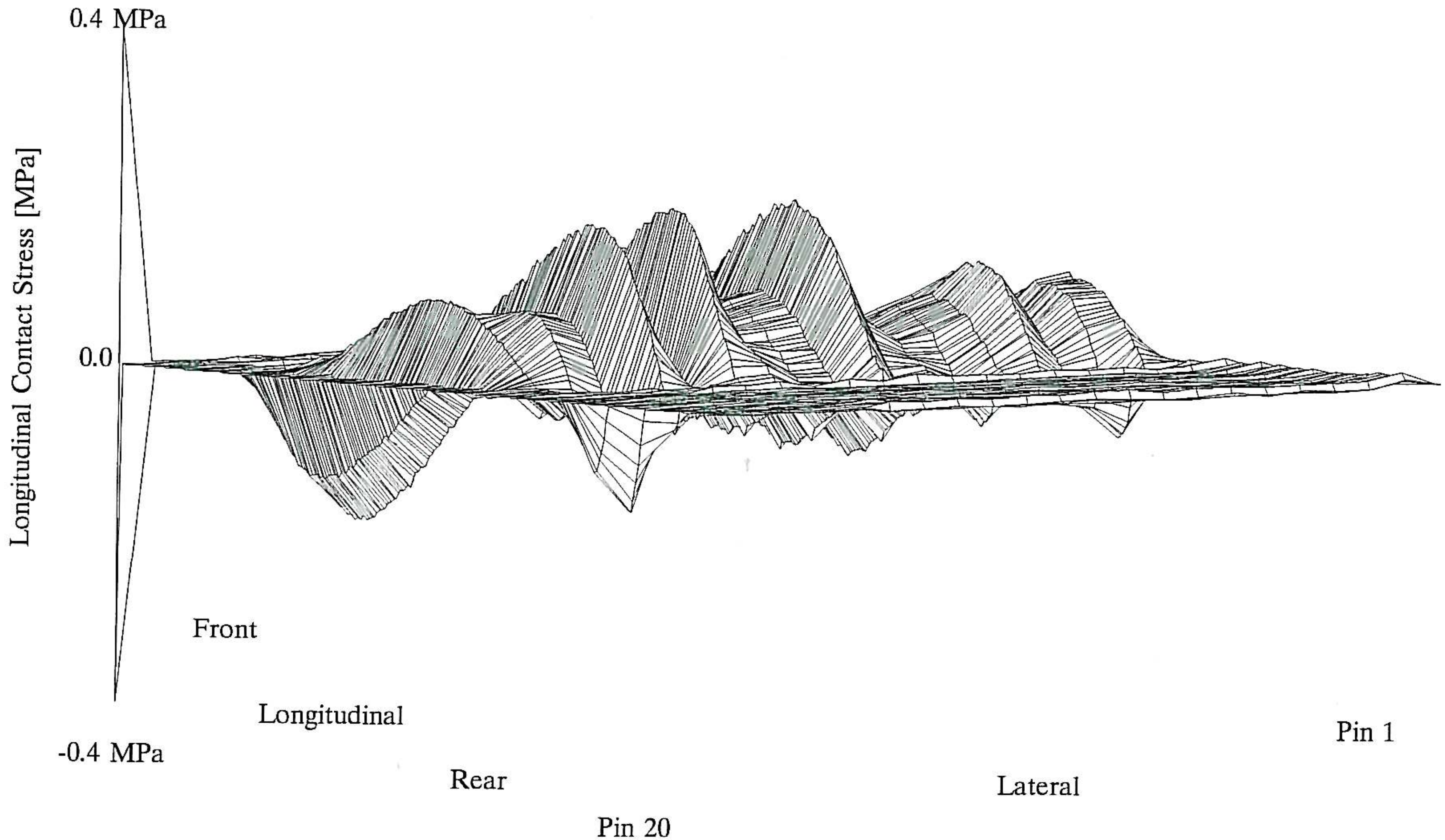
Used Bridgestone 425/65R22.5 R160AZ

FIGURE C3Y

Filename : nosc97hy

Applied Vertical Load (HVS) = 75 kN
Measured Longitudinal Load = 1.382 kN
Max. Stress = 0.2066 MPa
Min. Stress = -0.1827 MPa

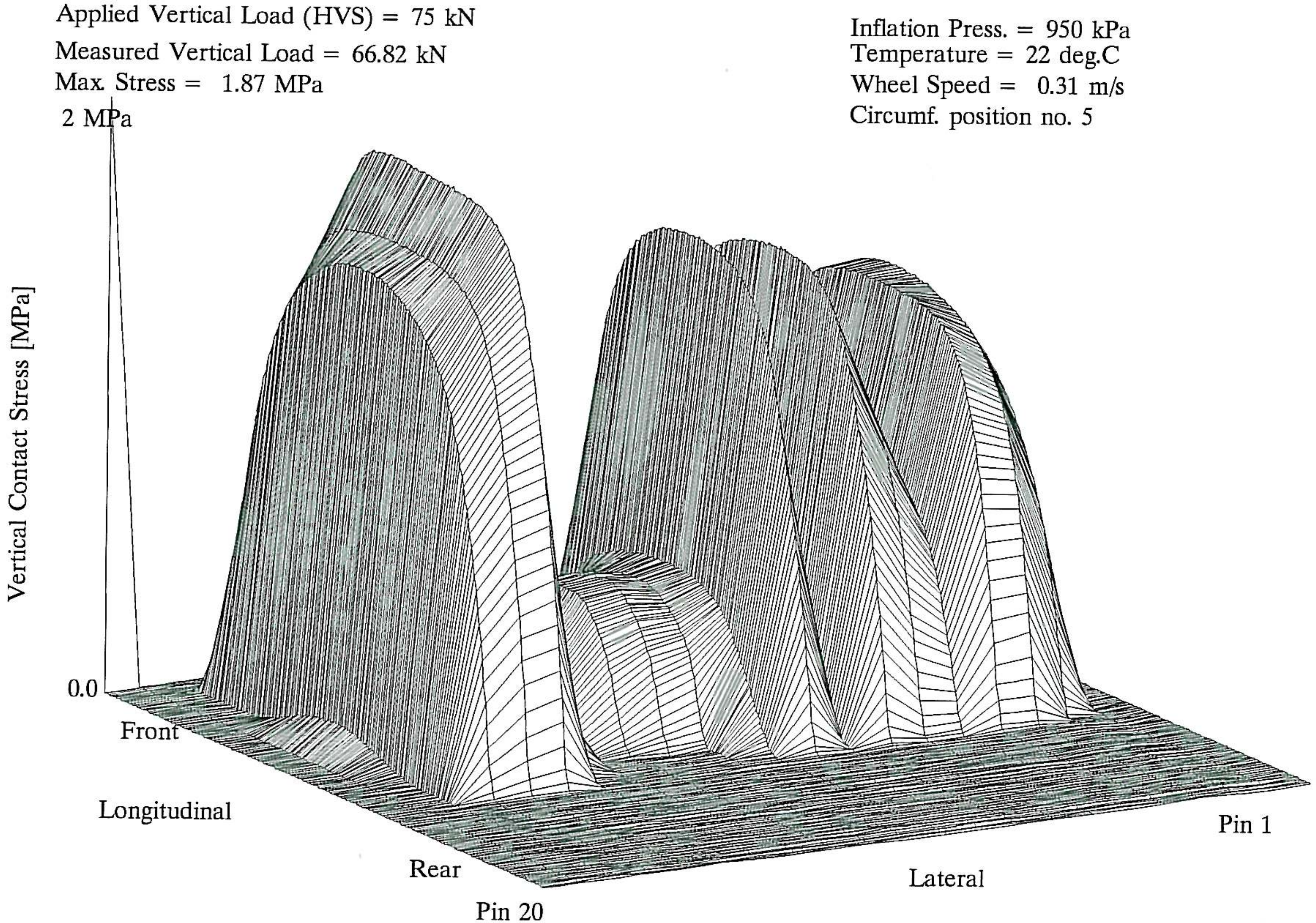
Inflation Press. = 950 kPa
Temperature = 21 deg.C
Wheel Speed = 0.31 m/s
Circumf. position no. 4



Used Bridgestone 425/65R22.5 R160AZ

Filename : nosc97hx

FIGURE C3X



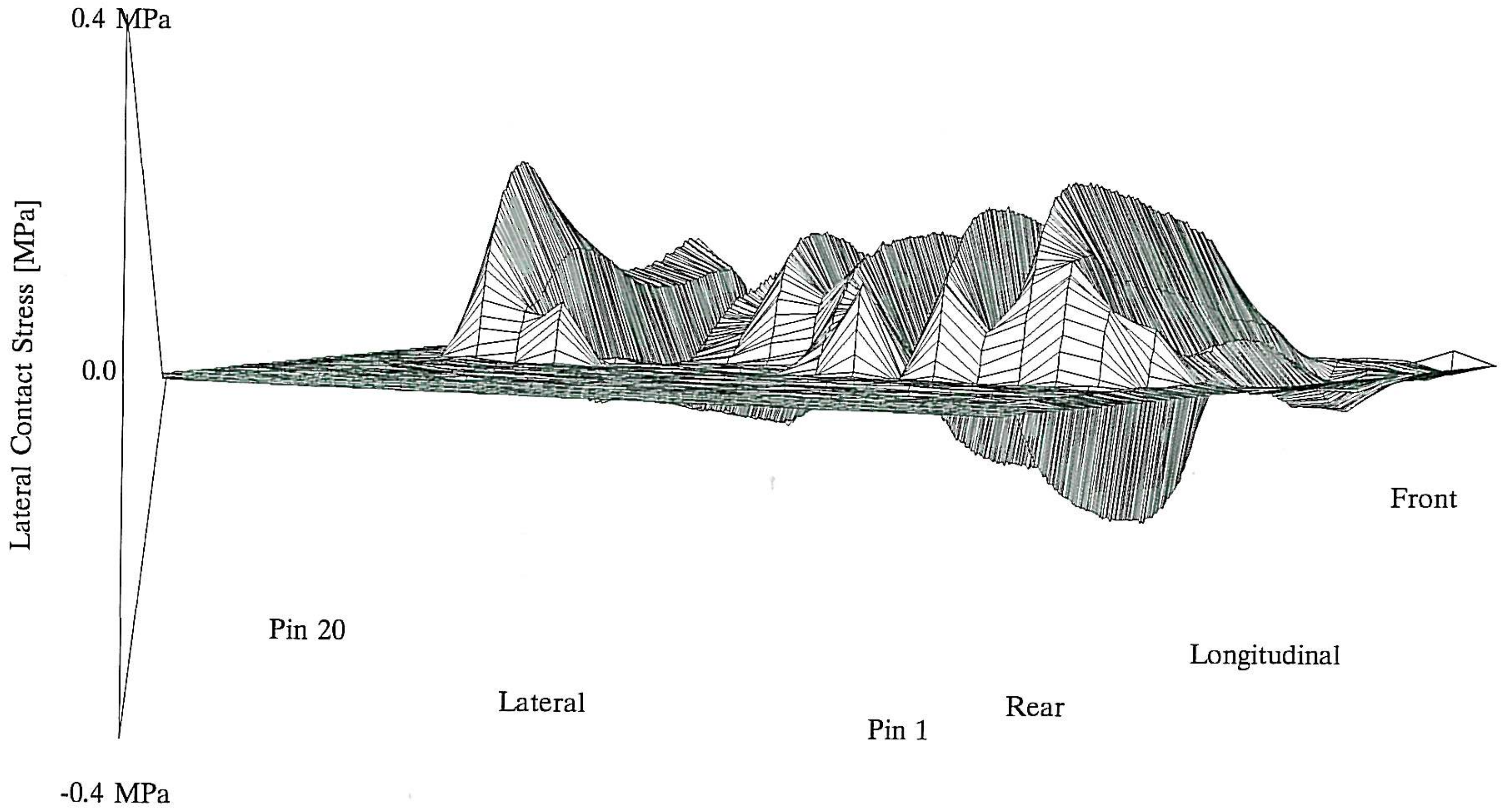
Used Bridgestone 425/65R22.5 R160AZ

FIGURE C4Z

Filename : nosc97jz

Applied Vertical Load (HVS) = 75 kN
Measured Lateral Load = 2.756 kN
Max. Stress = 0.2172 MPa
Min. Stress = -0.1747 MPa

Inflation Press. = 950 kPa
Temperature = 22 deg.C
Wheel Speed = 0.31 m/s
Circumf. position no. 5



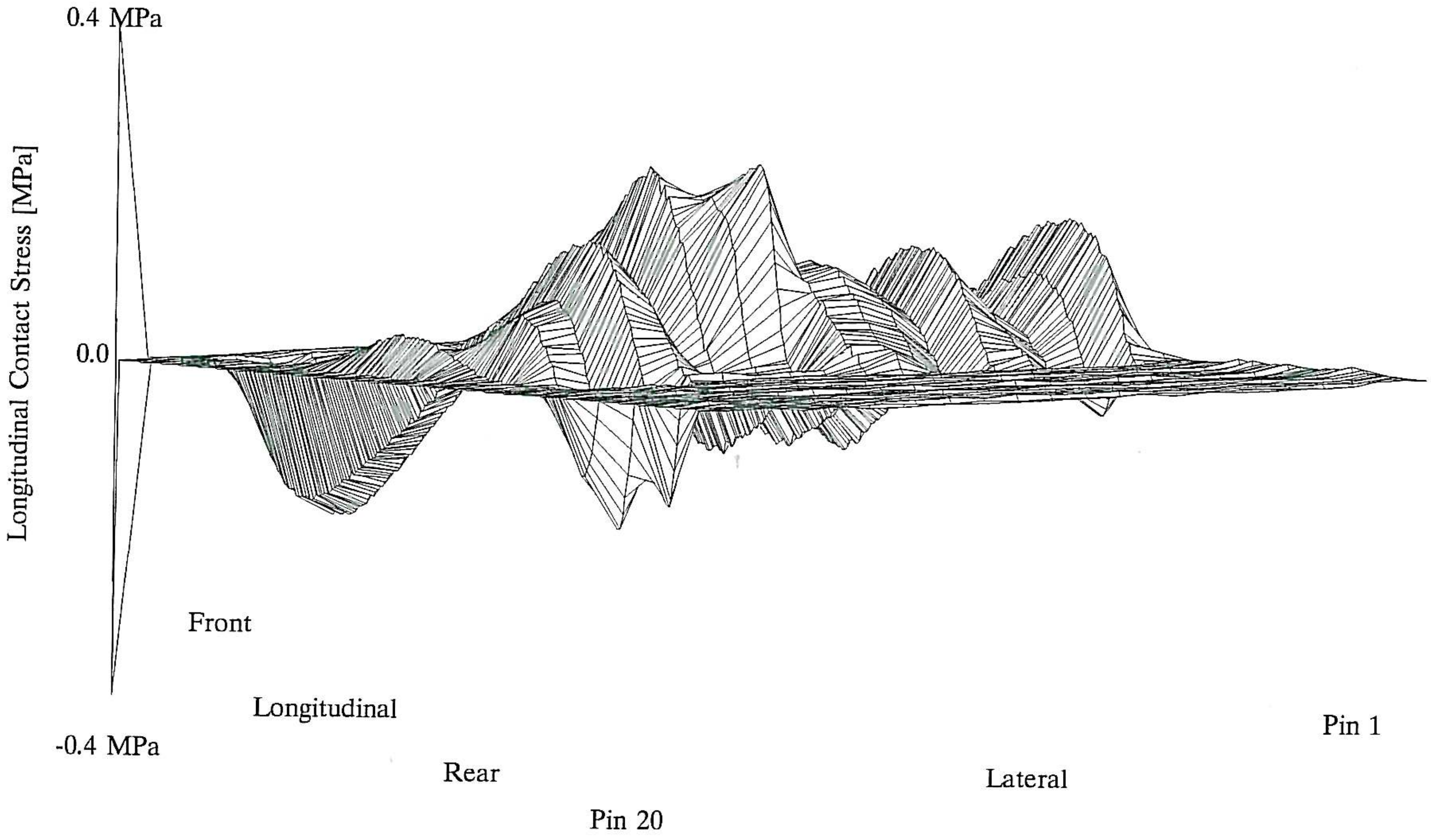
Used Bridgestone 425/65R22.5 R160AZ

FIGURE C4Y

Filename : nosc97jy

Applied Vertical Load (HVS) = 75 kN
Measured Longitudinal Load = 2.067 kN
Max. Stress = 0.2473 MPa
Min. Stress = -0.1834 MPa

Inflation Press. = 950 kPa
Temperature = 22 deg.C
Wheel Speed = 0.31 m/s
Circumf. position no. 5



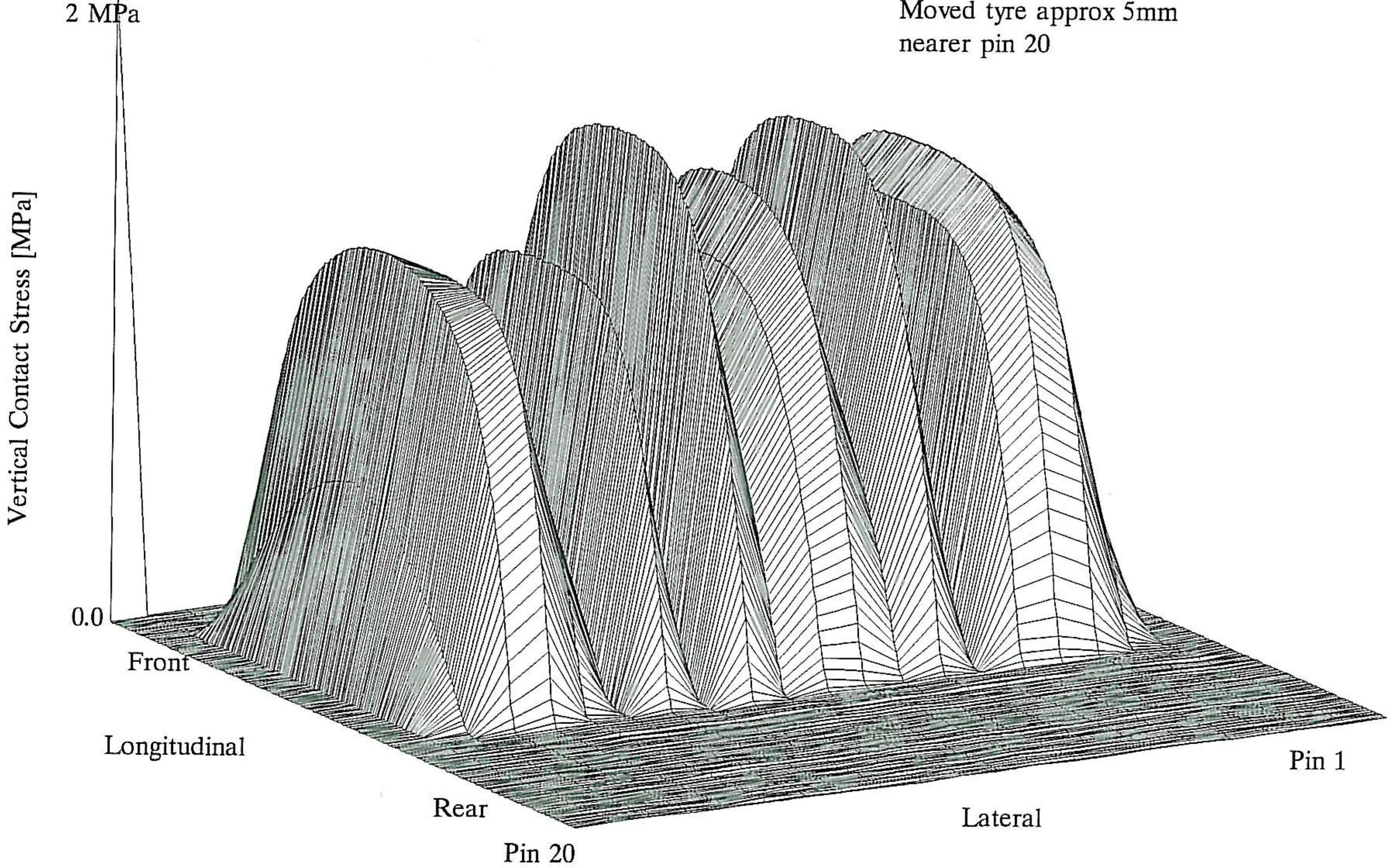
Used Bridgestone 425/65R22.5 R160AZ

Filename : nosc97jx

FIGURE C4X

Applied Vertical Load (HVS) = 75 kN
Measured Vertical Load = 73.39 kN
Max. Stress = 1.637 MPa

Inflation Press. = 950 kPa
Temperature = 21 deg.C
Wheel Speed = 0.31 m/s
Moved tyre approx 5mm
nearer pin 20



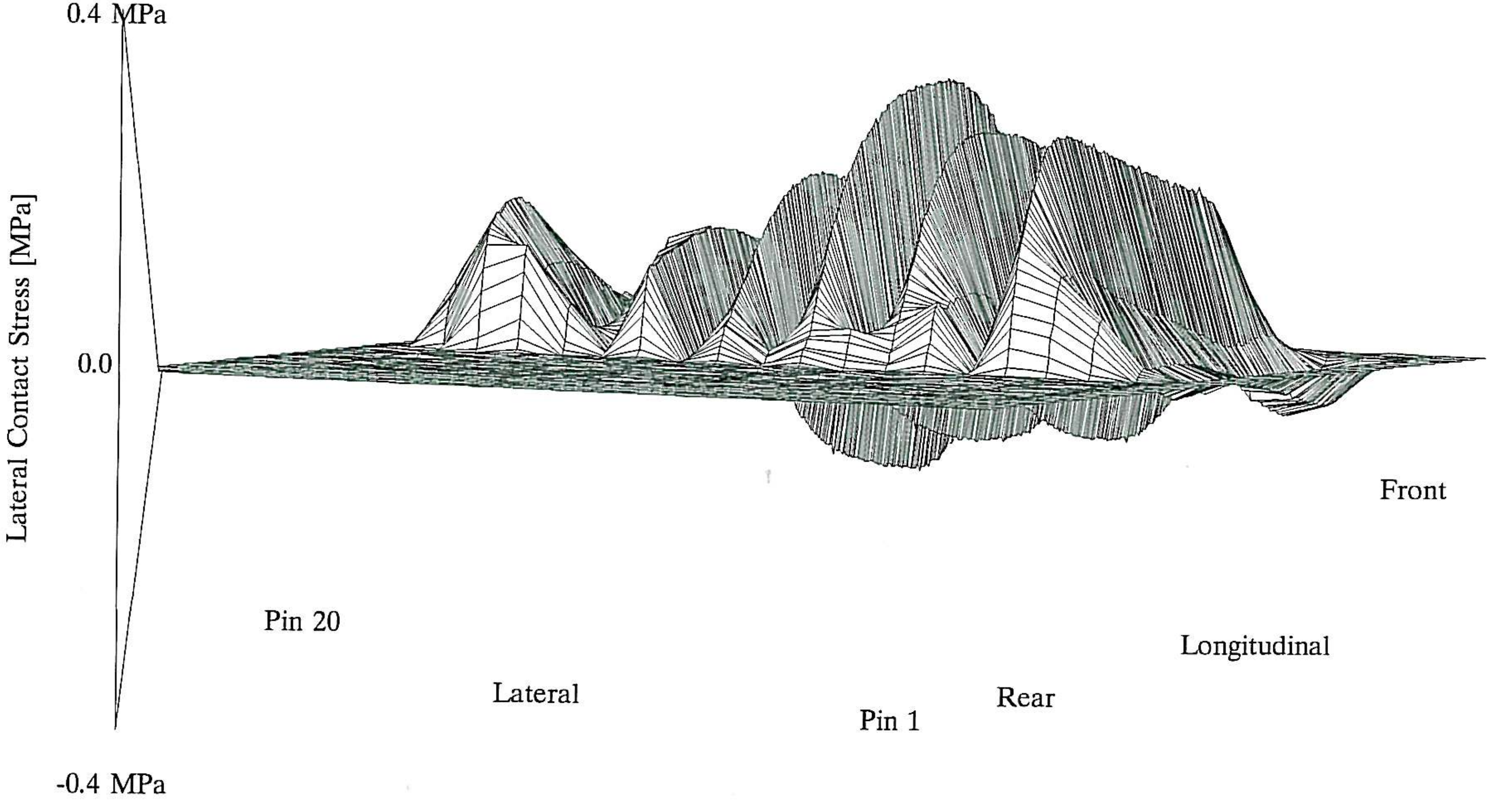
Used Bridgestone 425/65R22.5 R160AZ

Filename : nosc97pz

FIGURE C5Z

Applied Vertical Load (HVS) = 75 kN
Measured Lateral Load = 4.447 kN
Max. Stress = 0.3048 MPa
Min. Stress = -0.1342 MPa

Inflation Press. = 950 kPa
Temperature = 21 deg.C
Wheel Speed = 0.31 m/s
Moved tyre approx 5mm
nearer pin 20



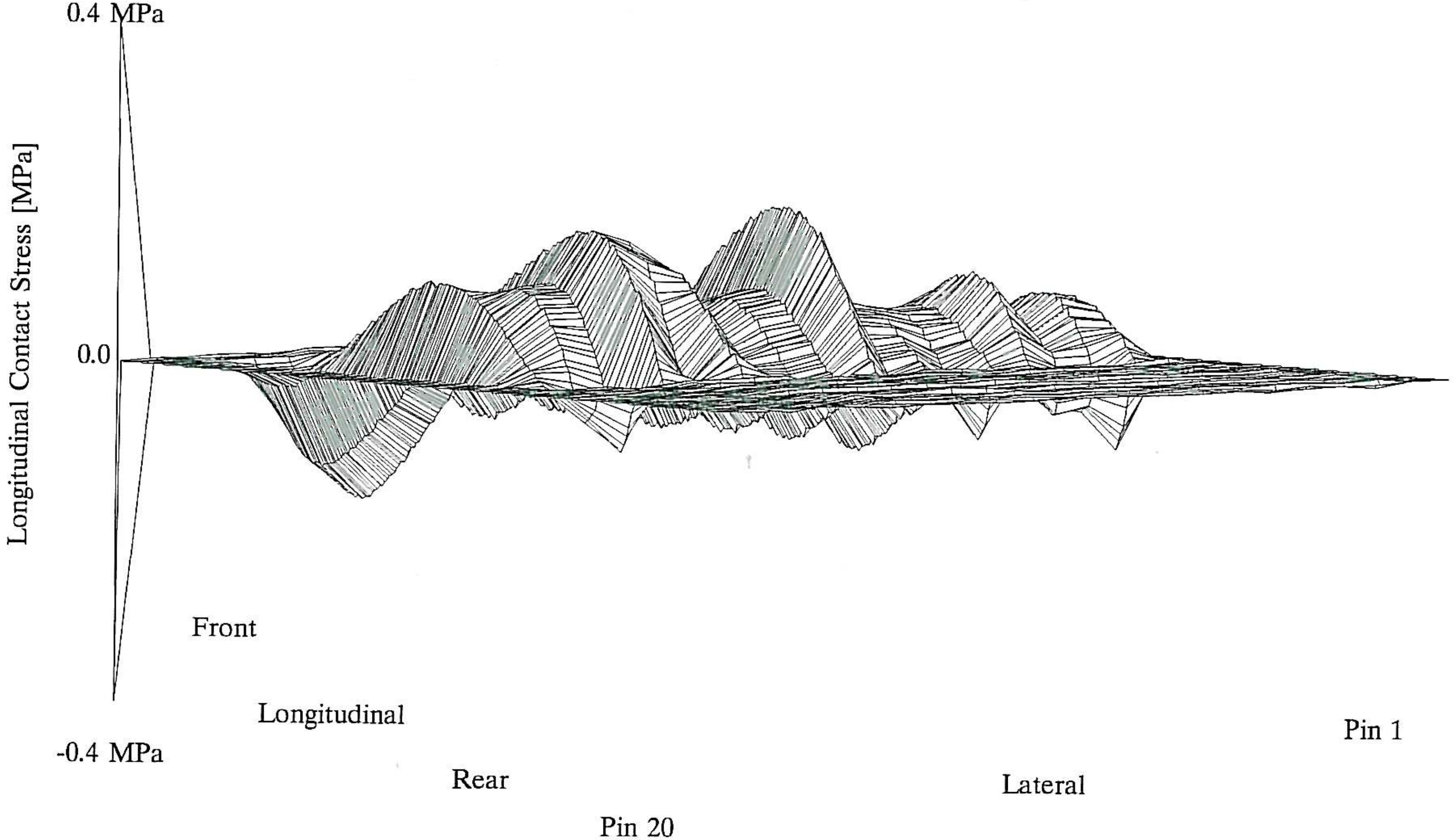
Used Bridgestone 425/65R22.5 R160AZ

Filename : nosc97py

FIGURE C5Y

Applied Vertical Load (HVS) = 75 kN
Measured Longitudinal Load = 1.576 kN
Max. Stress = 0.1904 MPa
Min. Stress = -0.1588 MPa

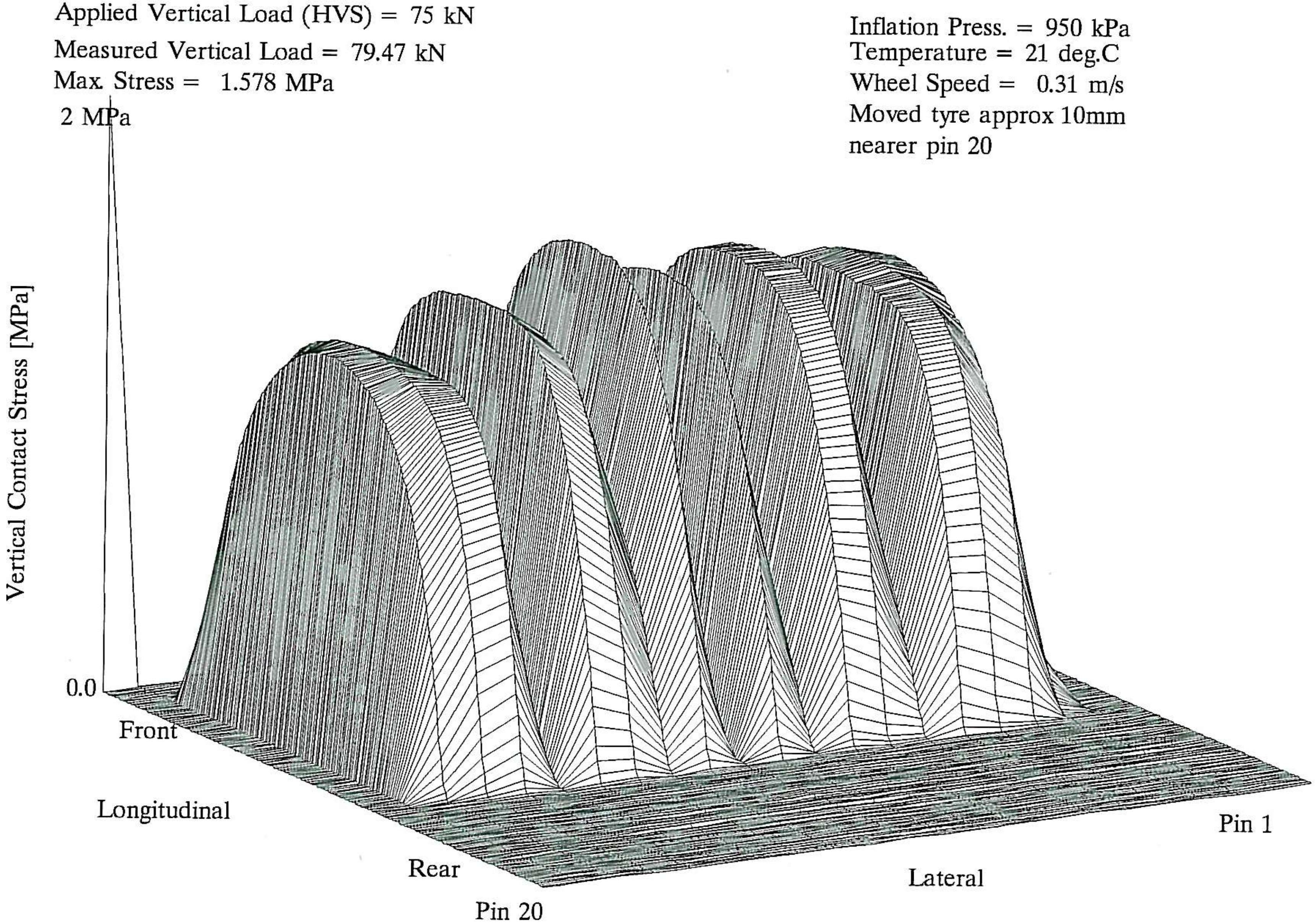
Inflation Press. = 950 kPa
Temperature = 21 deg.C
Wheel Speed = 0.31 m/s
Moved tyre approx 5mm
nearer pin 20



Used Bridgestone 425/65R22.5 R160AZ

FIGURE C5X

Filename : nosc97px



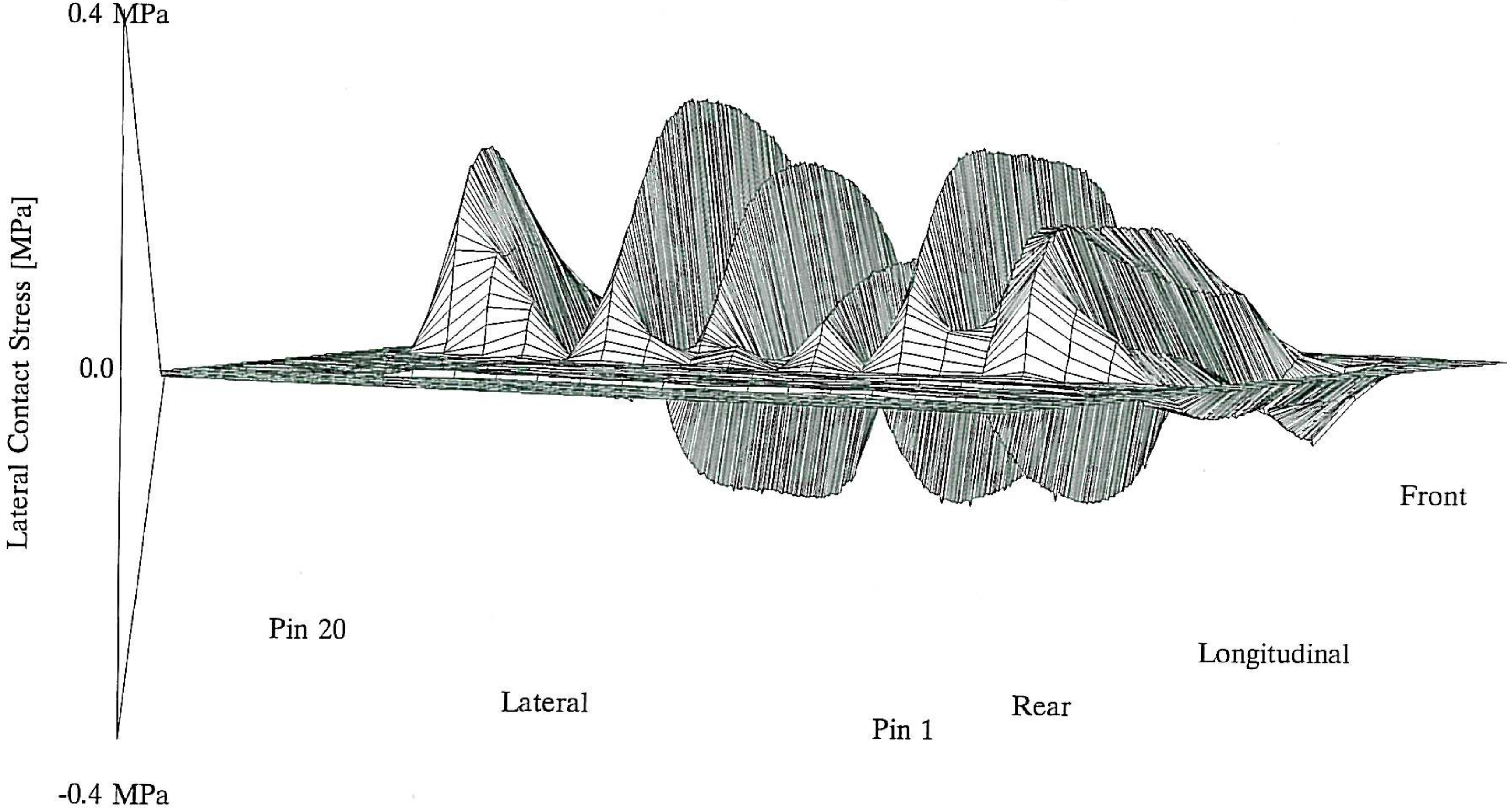
Used Bridgestone 425/65R22.5 R160AZ

Filename : nosc97tz

FIGURE C6Z

Applied Vertical Load (HVS) = 75 kN
Measured Lateral Load = 2.877 kN
Max. Stress = 0.2802 MPa
Min. Stress = -0.166 MPa

Inflation Press. = 950 kPa
Temperature = 21 deg.C
Wheel Speed = 0.31 m/s
Moved tyre approx 10mm
nearer pin 20



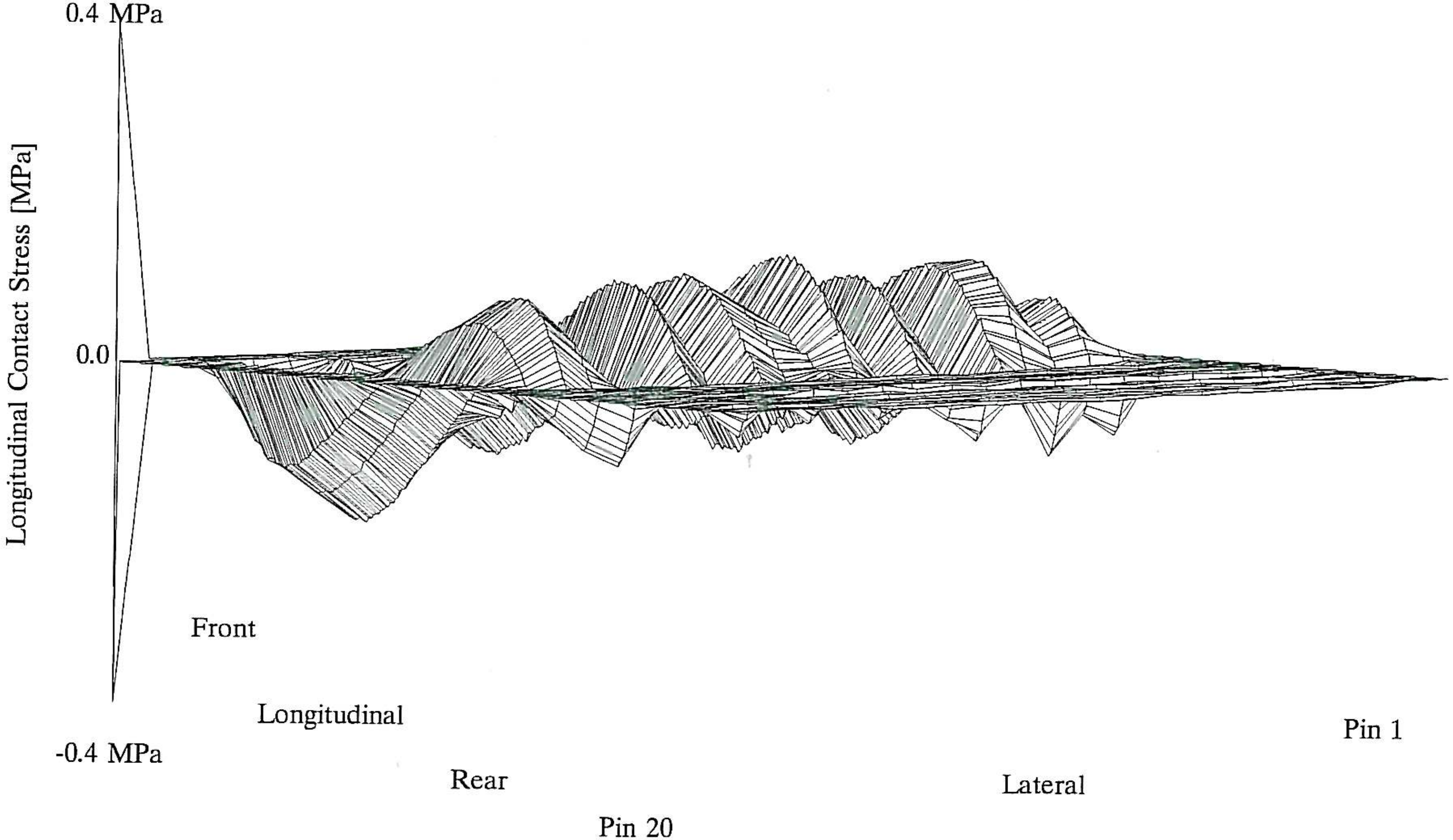
Used Bridgestone 425/65R22.5 R160AZ

Filename : nosc97ty

FIGURE C6Y

Applied Vertical Load (HVS) = 75 kN
Measured Longitudinal Load = -0.5575 kN
Max. Stress = 0.1344 MPa
Min. Stress = -0.187 MPa

Inflation Press. = 950 kPa
Temperature = 21 deg.C
Wheel Speed = 0.31 m/s
Moved tyre approx 10mm nearer pin 20



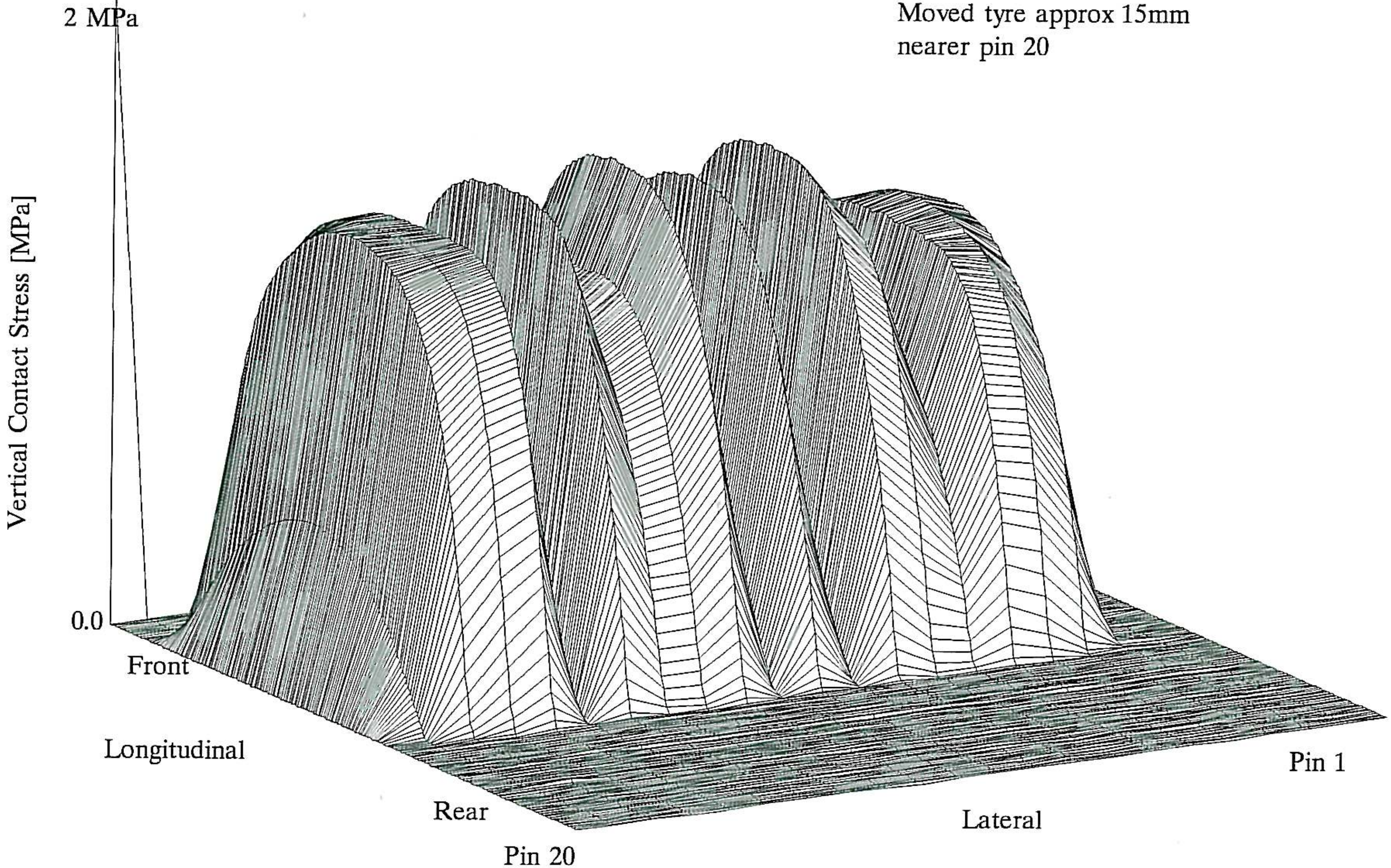
Used Bridgestone 425/65R22.5 R160AZ

Filename : nosc97tx

FIGURE C6X

Applied Vertical Load (HVS) = 75 kN
Measured Vertical Load = 78.34 kN
Max. Stress = 1.55 MPa

Inflation Press. = 950 kPa
Temperature = 16 deg.C
Wheel Speed = 0.31 m/s
Moved tyre approx 15mm
nearer pin 20



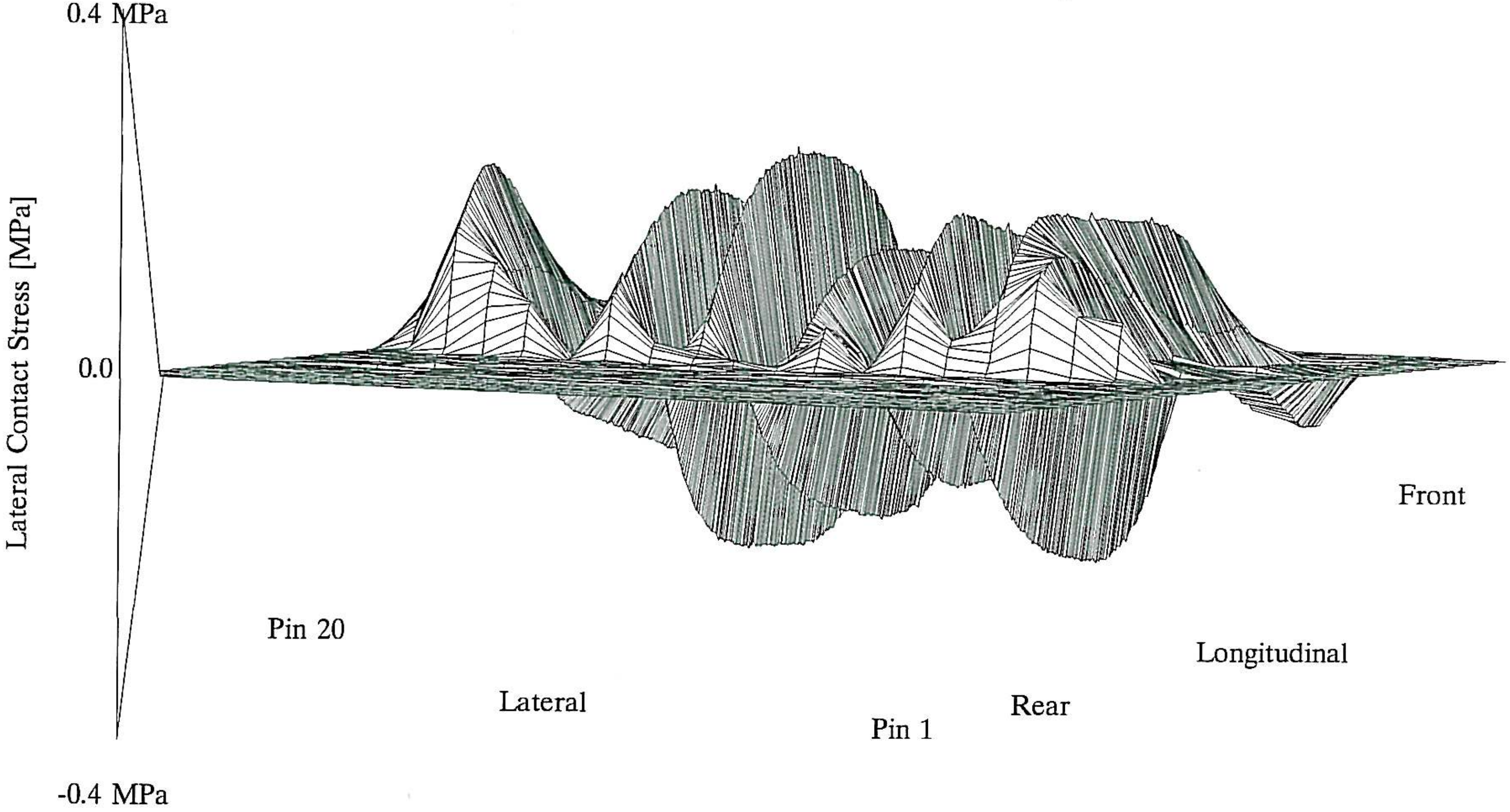
Used Bridgestone 425/65R22.5 R160AZ

Filename : nosc97xz

FIGURE C7Z

Applied Vertical Load (HVS) = 75 kN
Measured Lateral Load = 1.144 kN
Max. Stress = 0.2278 MPa
Min. Stress = -0.2224 MPa

Inflation Press. = 950 kPa
Temperature = 16 deg.C
Wheel Speed = 0.31 m/s
Moved tyre approx 15mm nearer pin 20



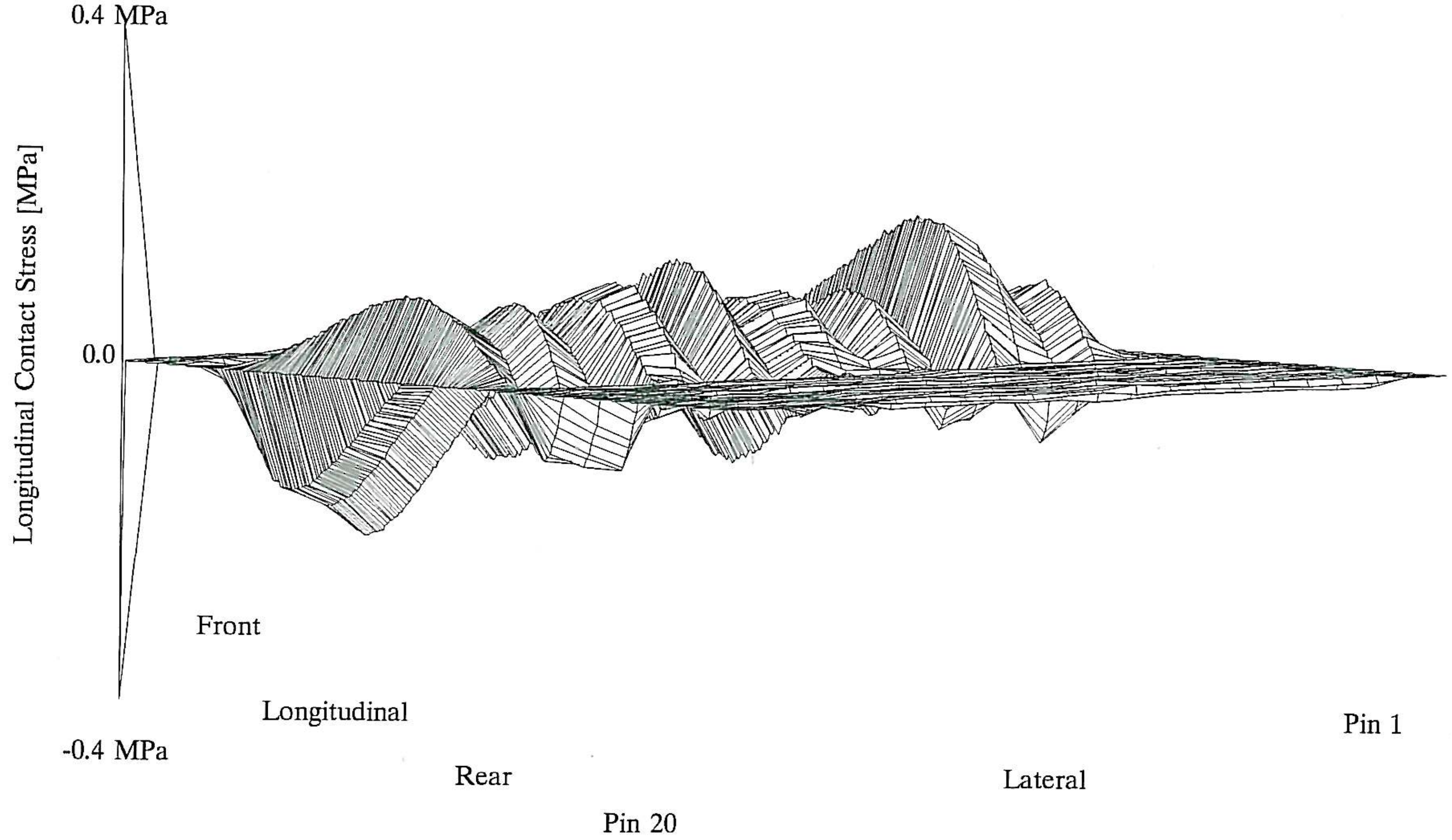
Filename : nosc97xy

Used Bridgestone 425/65R22.5 R160AZ

FIGURE C7Y

Applied Vertical Load (HVS) = 75 kN
Measured Longitudinal Load = -0.1596 kN
Max. Stress = 0.1715 MPa
Min. Stress = -0.2048 MPa

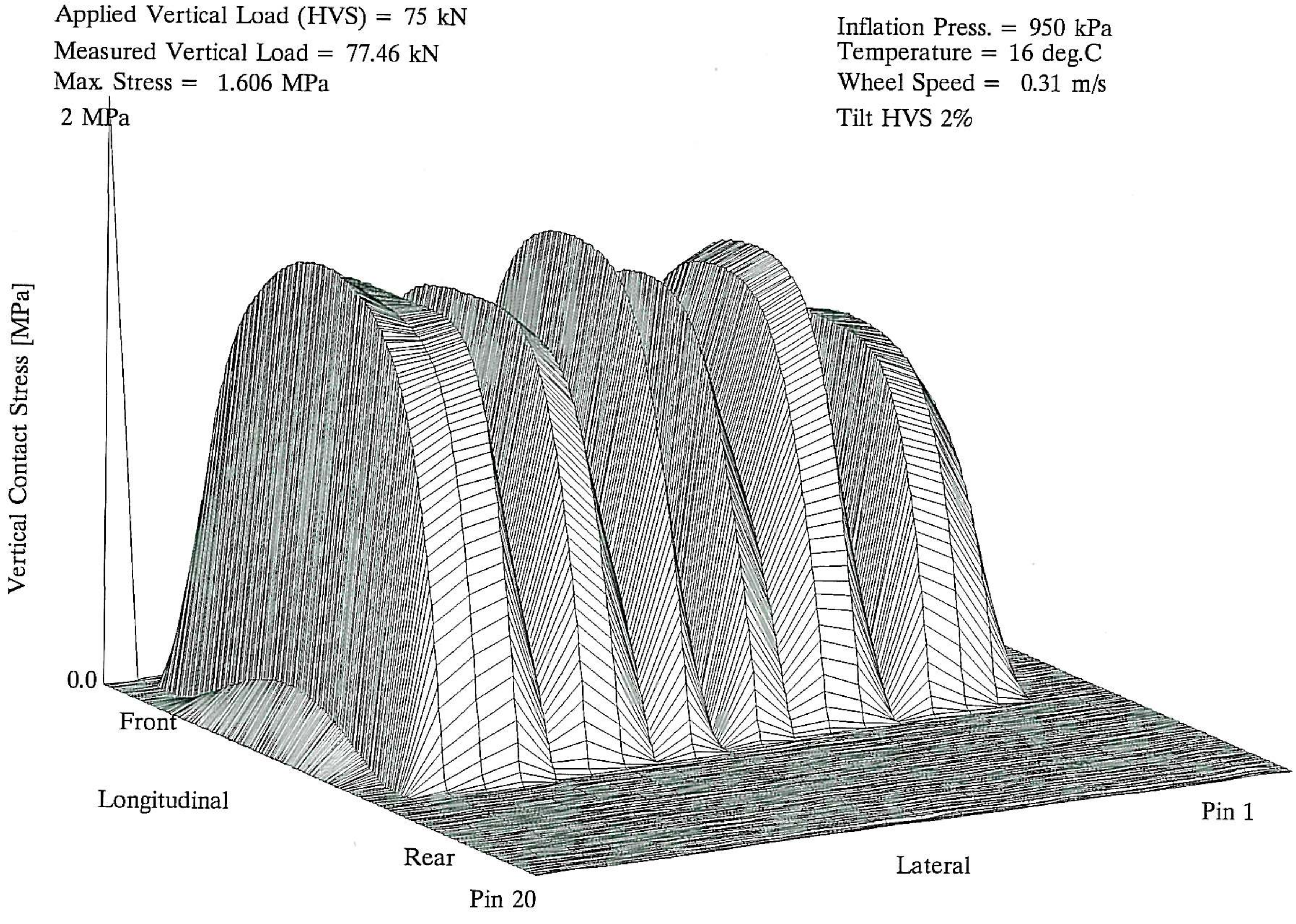
Inflation Press. = 950 kPa
Temperature = 16 deg.C
Wheel Speed = 0.31 m/s
Moved tyre approx 15mm
nearer pin 20



Used Bridgestone 425/65R22.5 R160AZ

Filename : nosc97xx

FIGURE C7X



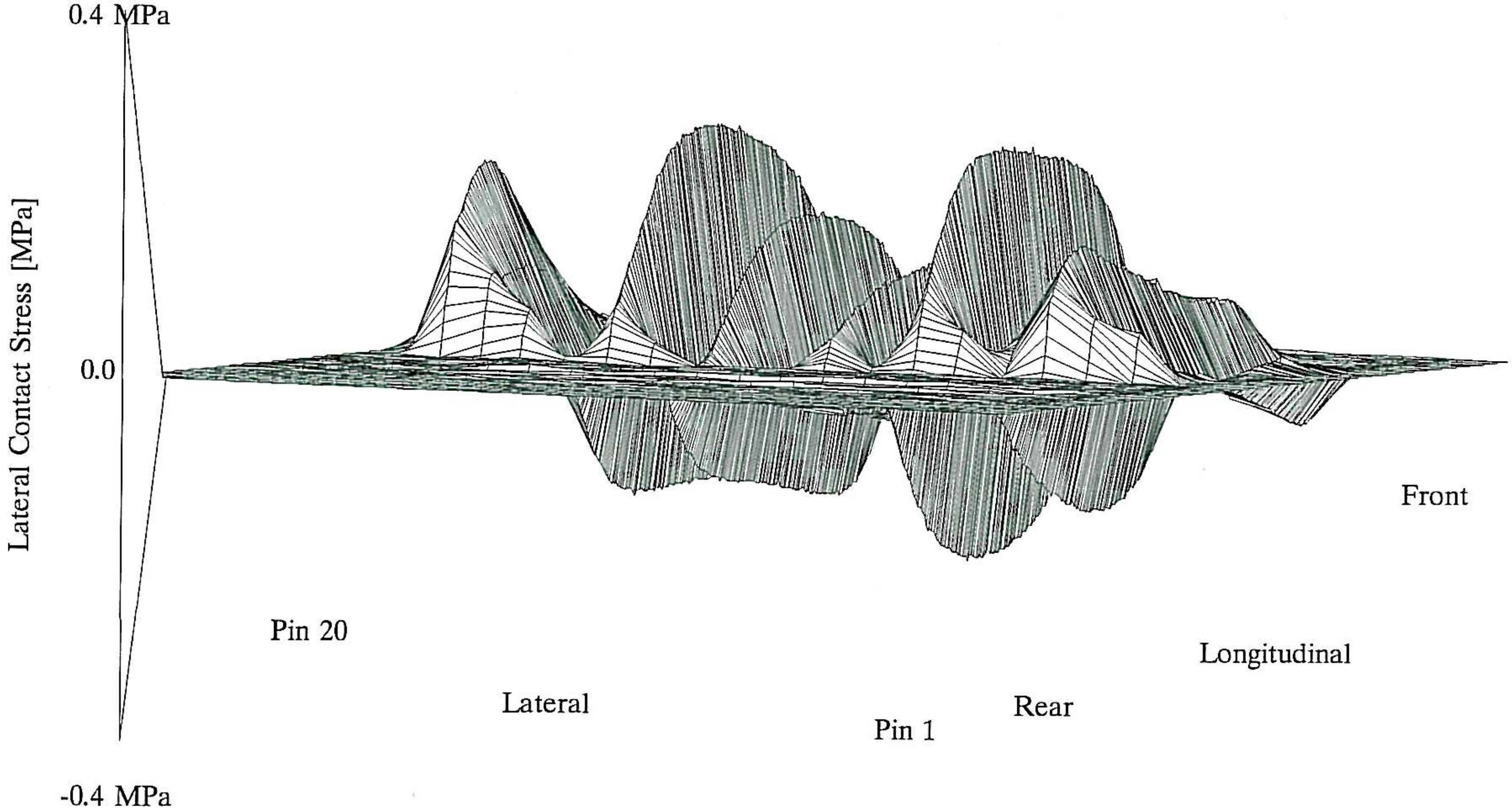
Used Bridgestone 425/65R22.5 R160AZ

FIGURE C8Z

Filename : nolc97bz

Applied Vertical Load (HVS) = 75 kN
Measured Lateral Load = 0.8912 kN
Max. Stress = 0.2492 MPa
Min. Stress = -0.2178 MPa

Inflation Press. = 950 kPa
Temperature = 16 deg.C
Wheel Speed = 0.31 m/s
Tilt HVS 2%



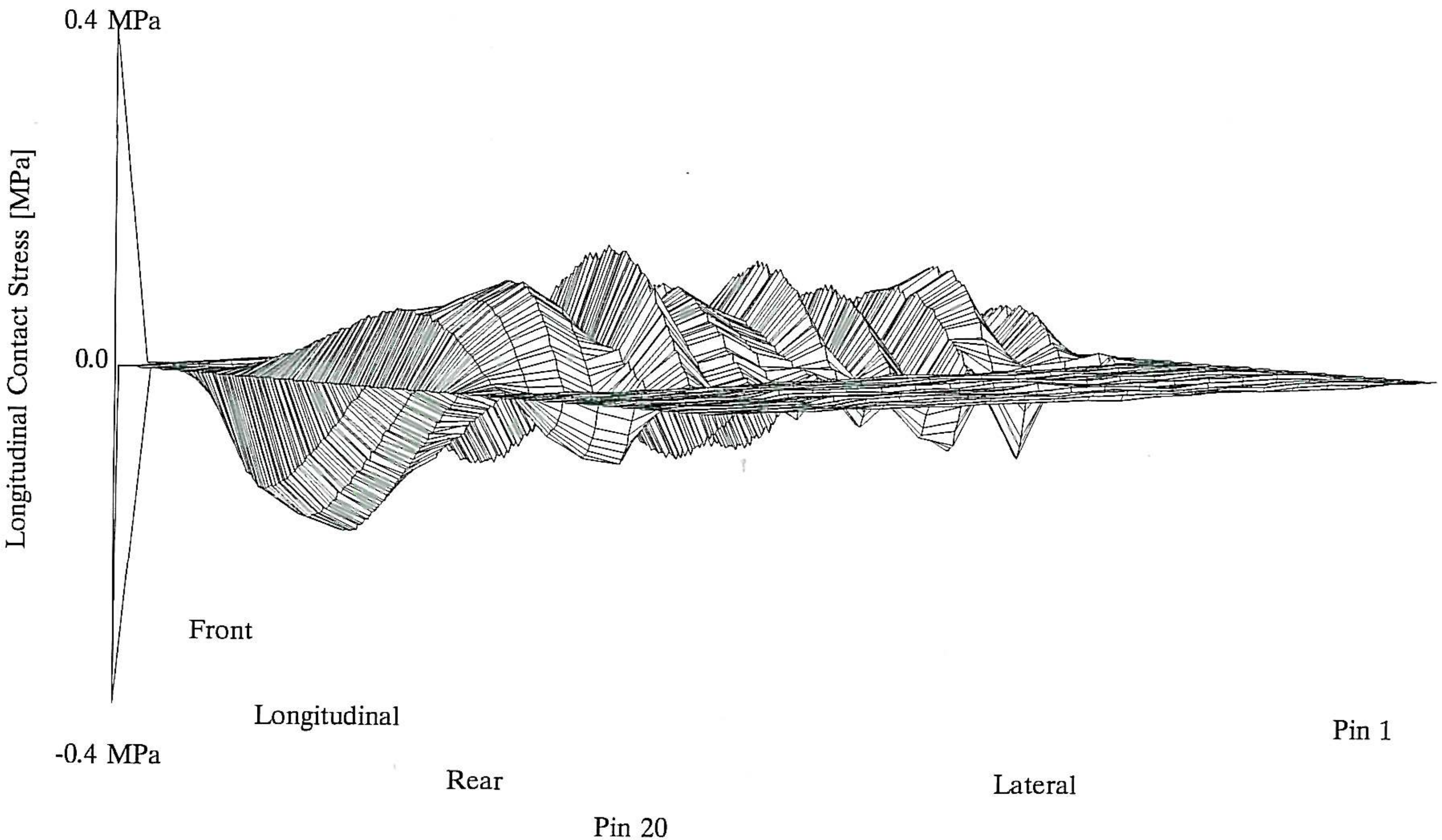
Used Bridgestone 425/65R22.5 R160AZ

FIGURE C8Y

Filename : nolc97by

Applied Vertical Load (HVS) = 75 kN
Measured Longitudinal Load = 0.1129 kN
Max. Stress = 0.1595 MPa
Min. Stress = -0.1957 MPa

Inflation Press. = 950 kPa
Temperature = 16 deg.C
Wheel Speed = 0.31 m/s
Tilt HVS 2%



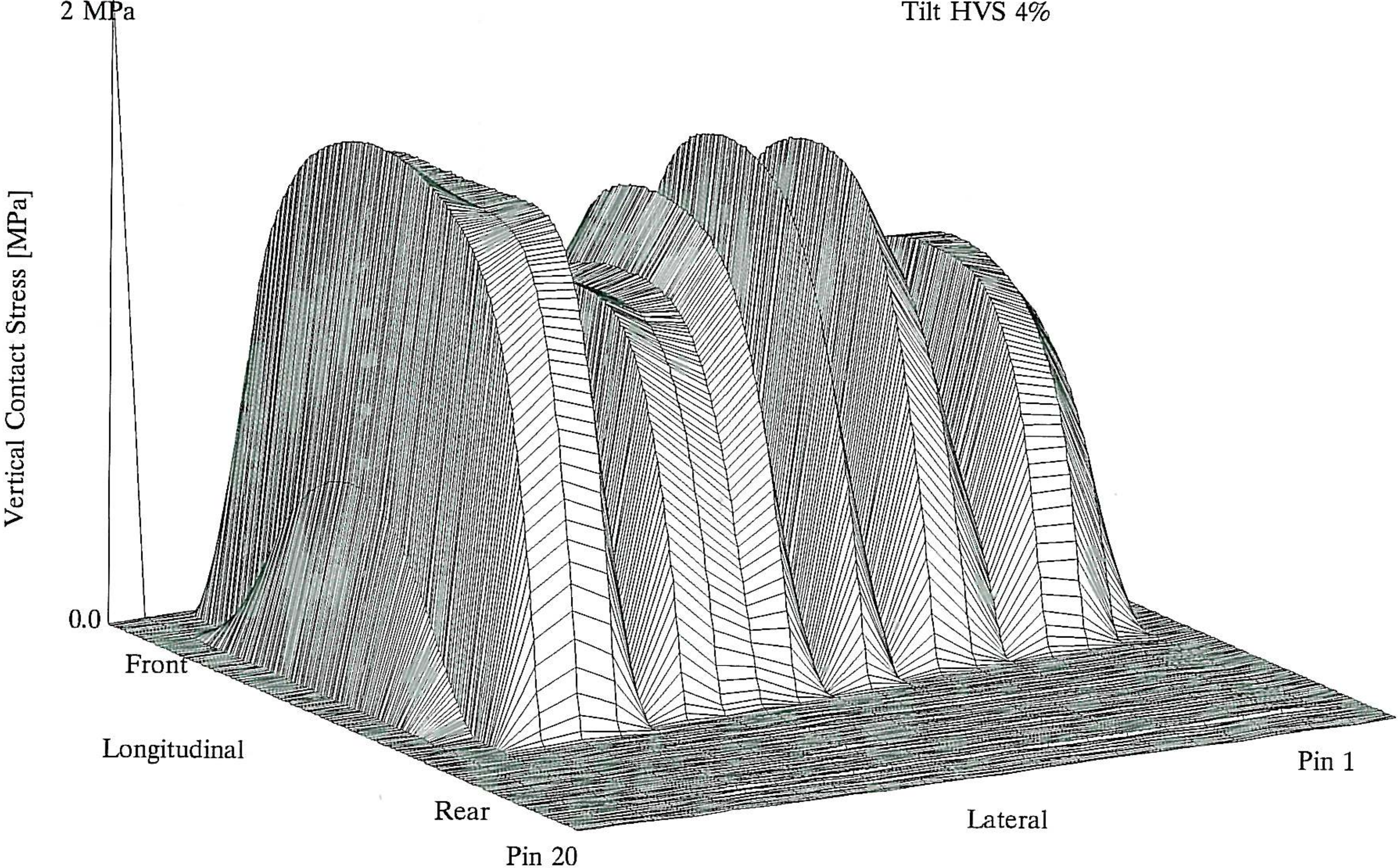
Used Bridgestone 425/65R22.5 R160AZ

Filename : nolc97bx

FIGURE C8X

Applied Vertical Load (HVS) = 75 kN
Measured Vertical Load = 78.52 kN
Max. Stress = 1.656 MPa

Inflation Press. = 950 kPa
Temperature = 22 deg.C
Wheel Speed = 0.31 m/s
Tilt HVS 4%



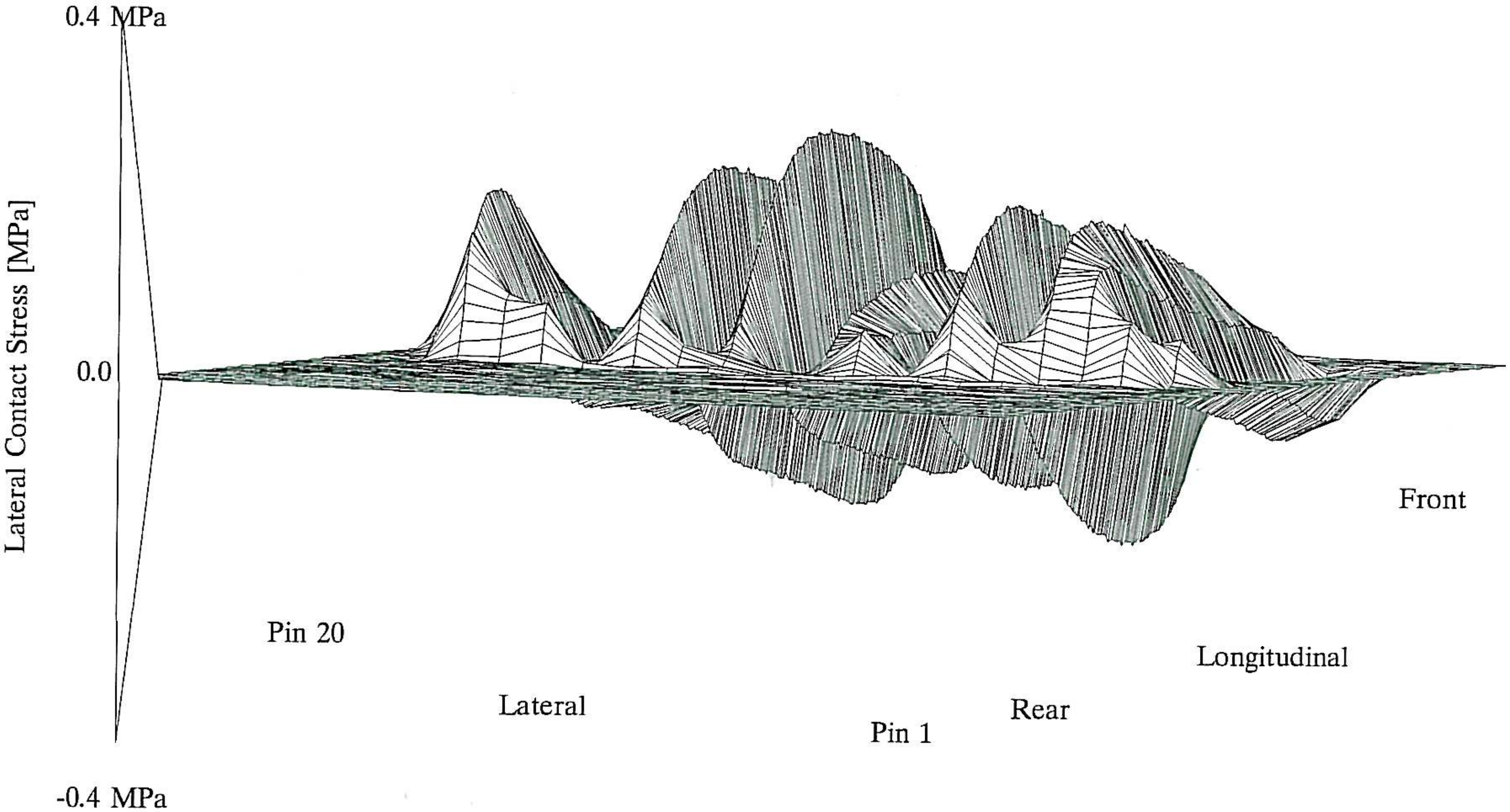
Used Bridgestone 425/65R22.5 R160AZ

FIGURE C9Z

Filename : nolc97fz

Applied Vertical Load (HVS) = 75 kN
Measured Lateral Load = 1.29 kN
Max. Stress = 0.2538 MPa
Min. Stress = -0.1971 MPa

Inflation Press. = 950 kPa
Temperature = 22 deg.C
Wheel Speed = 0.31 m/s
Tilt HVS 4%



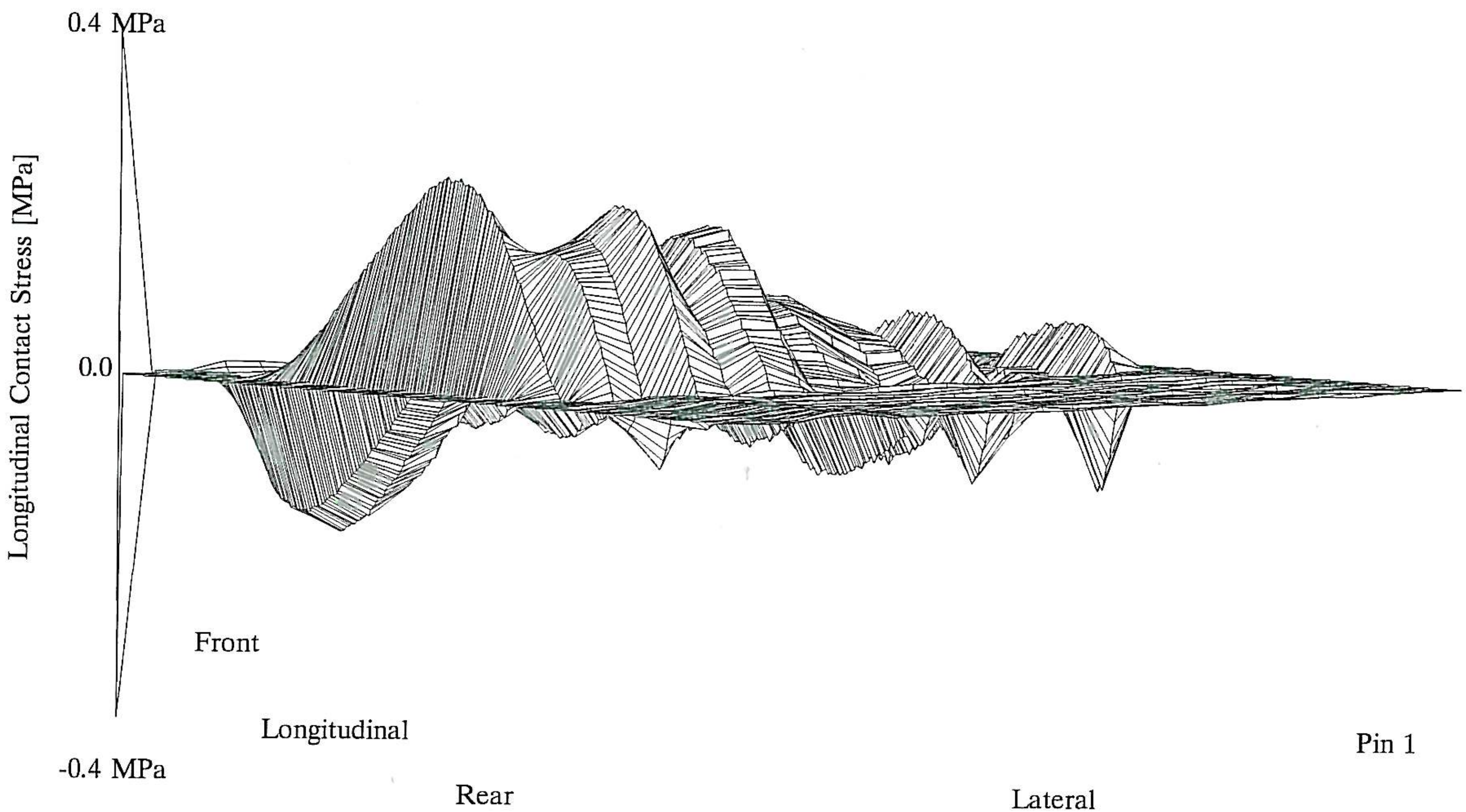
Used Bridgestone 425/65R22.5 R160AZ

FIGURE C9Y

Filename : nolc97fy

Applied Vertical Load (HVS) = 75 kN
Measured Longitudinal Load = 1.155 kN
Max. Stress = 0.2491 MPa
Min. Stress = -0.1834 MPa

Inflation Press. = 950 kPa
Temperature = 22 deg.C
Wheel Speed = 0.31 m/s
Tilt HVS 4%



Used Bridgestone 425/65R22.5 R160AZ

Filename : nolc97fx

FIGURE C9X

APPENDIX D:

"FOOTPRINTS "(REDUCED SCALE) OF THE LINTRACK *USED* BRIDGESTONE 425/65 R 22.5 R160AZ TYRE

FIGURE D1

BRIDGESTONE (160AZ)
500KPa
25kN
RADIAL

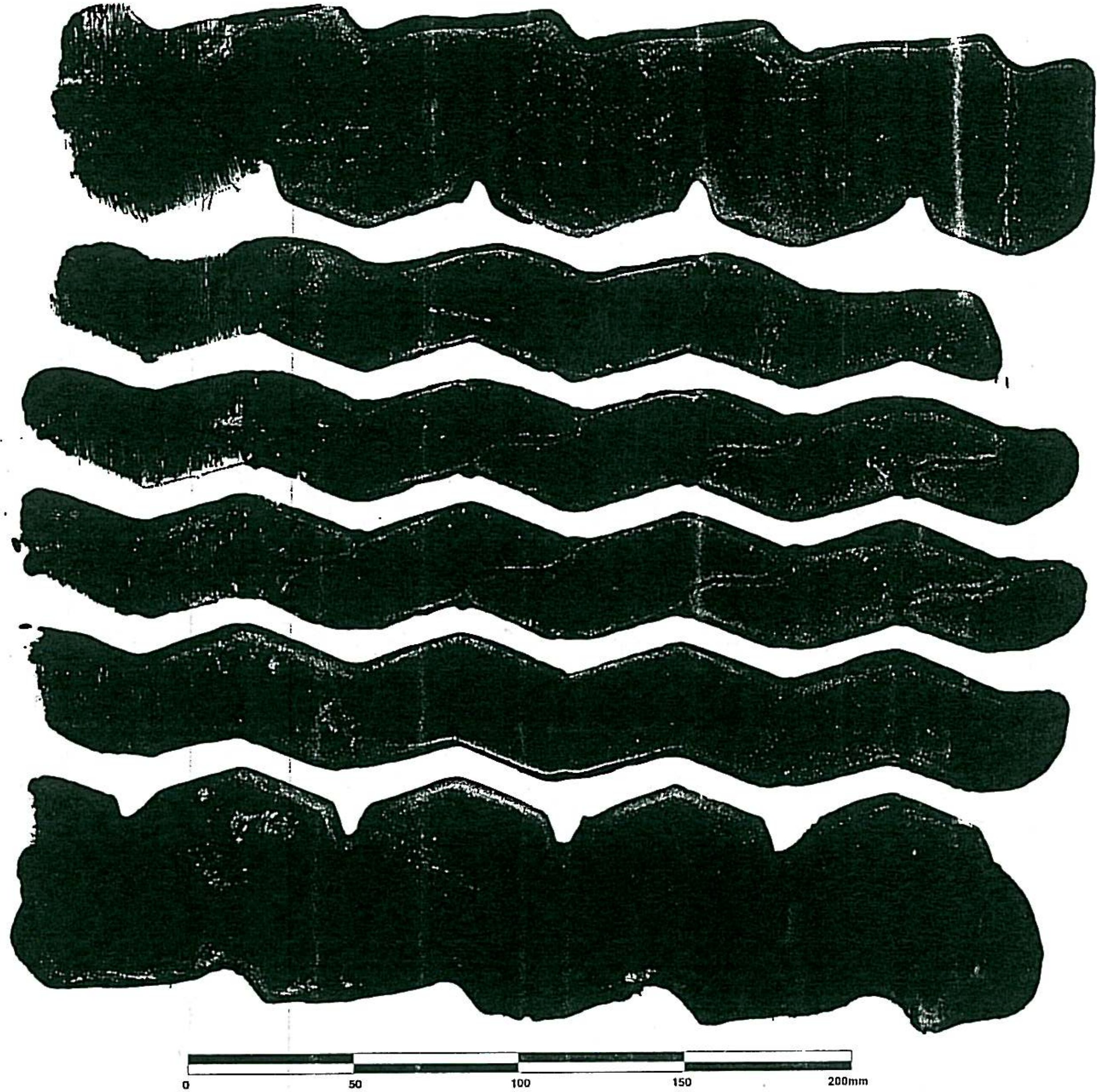


FIGURE D2

BRIDGESTONE (160AZ)
500KPa
50kN
RADIAL

FIGURE D3

BRIDGESTONE (160AZ)
500KPa
75kN
RADIAL

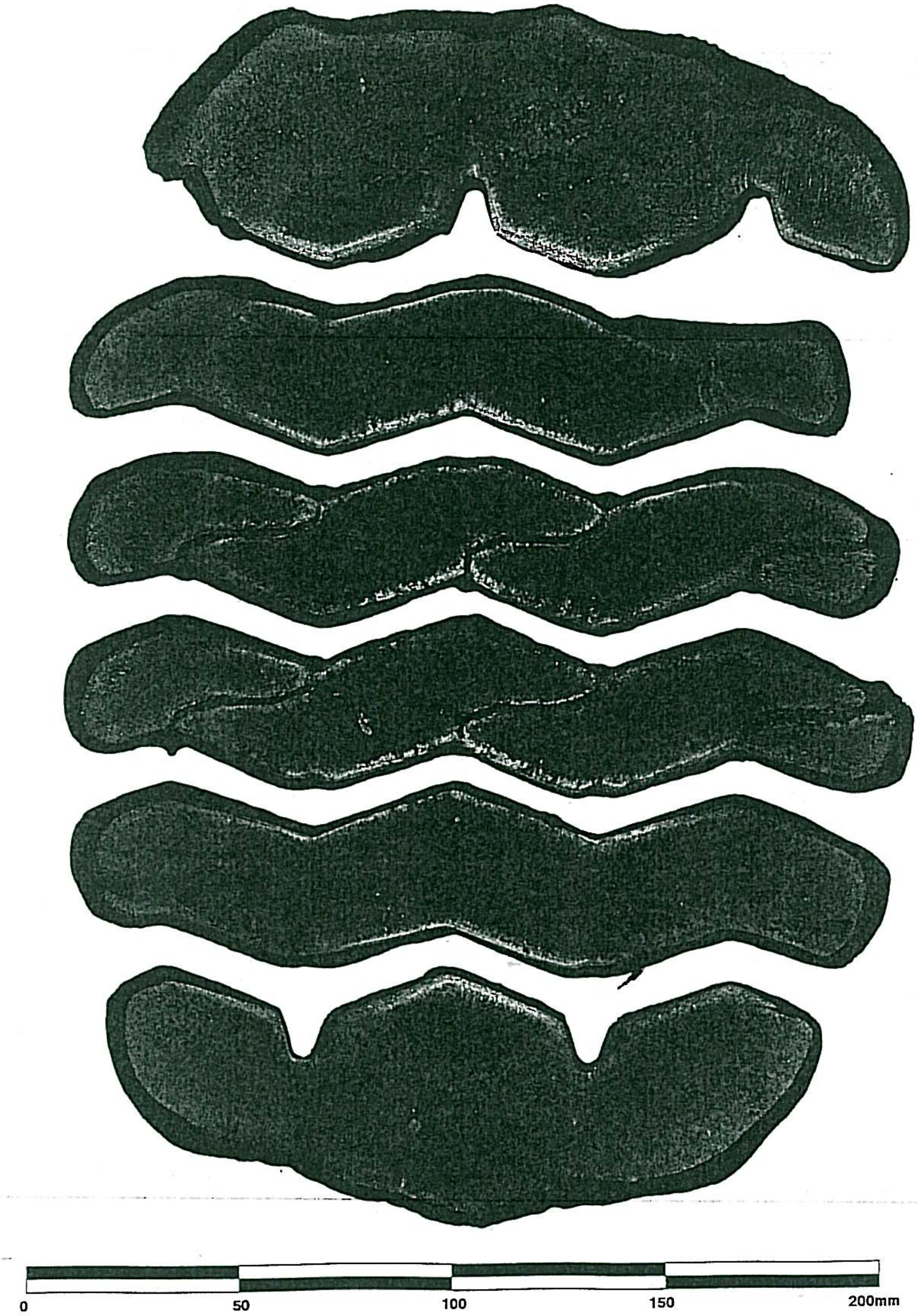


FIGURE D4

BRIDGESTONE (160AZ)
700KPa
25kN
RADIAL

FIGURE D5

BRIDGESTONE (160AZ)
700KPa
50kN
RADIAL

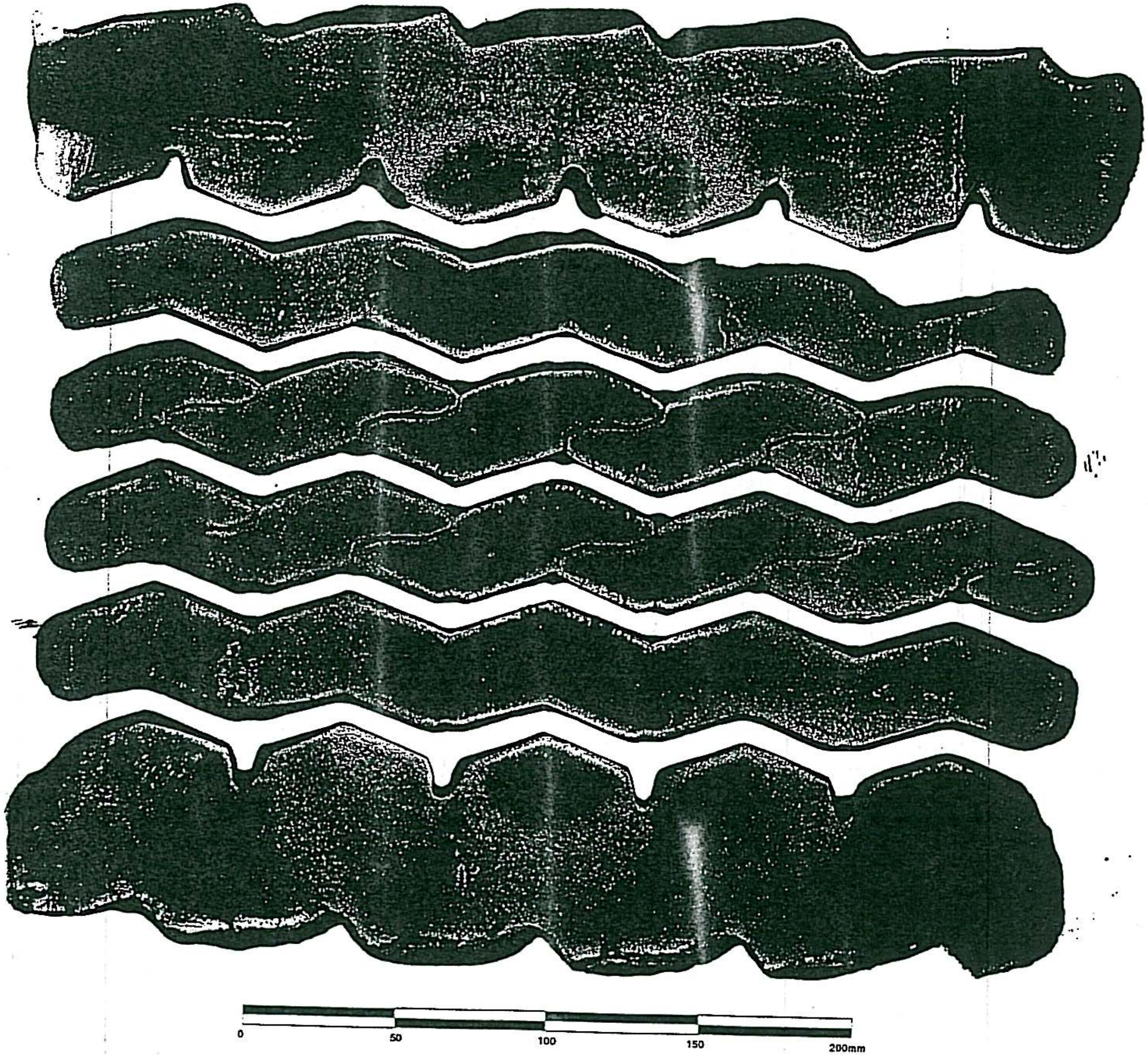


FIGURE D6

BRIDGESTONE (160AZ)
700KPa
75kN
RADIAL

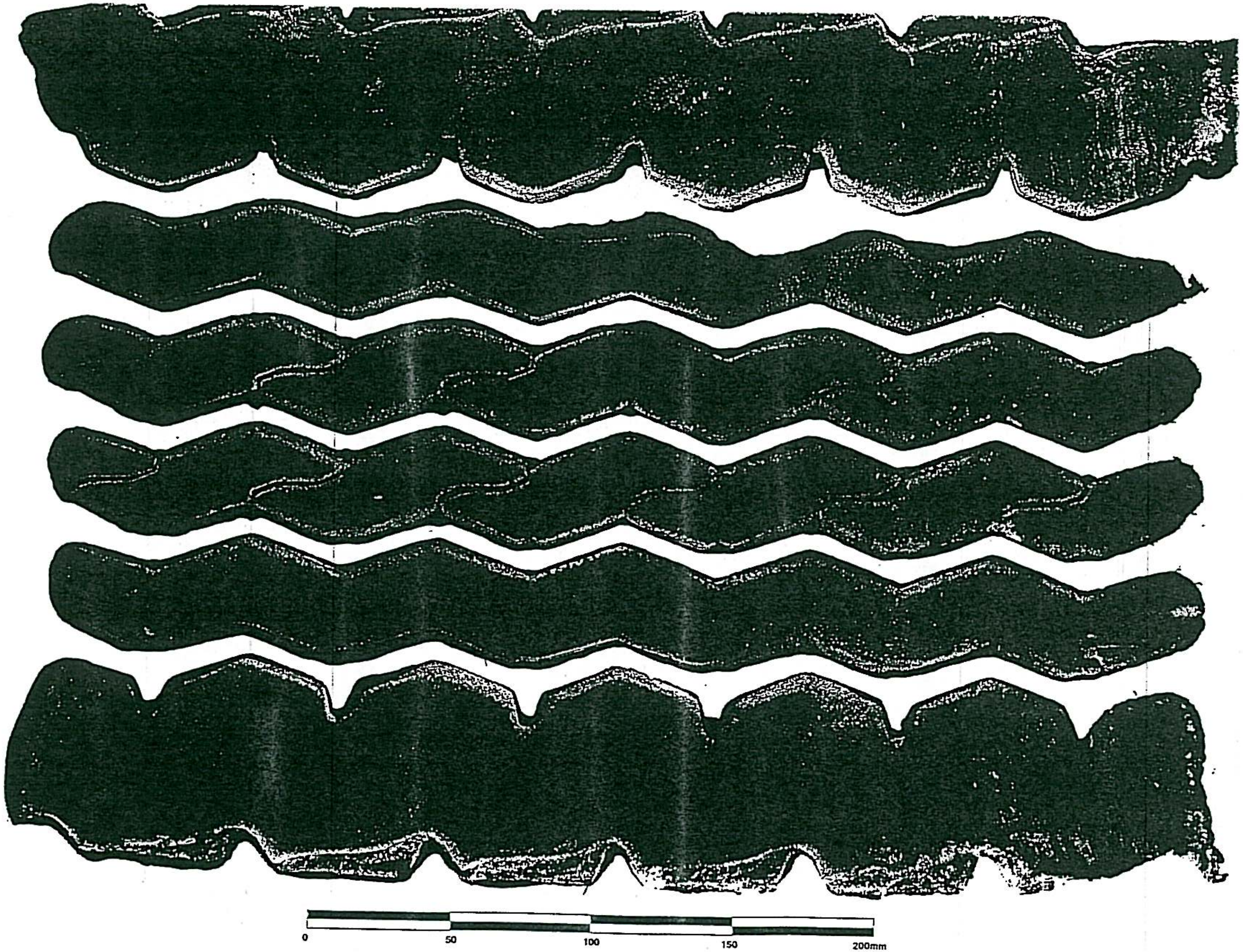


FIGURE D7

BRIDGESTONE (160AZ)
700KPa
100kN
RADIAL

FIGURE D8

BRIDGESTONE (160AZ)
900KPa
25kN
RADIAL

FIGURE D9

BRIDGESTONE (160AZ)
900KPa
50kN
RADIAL

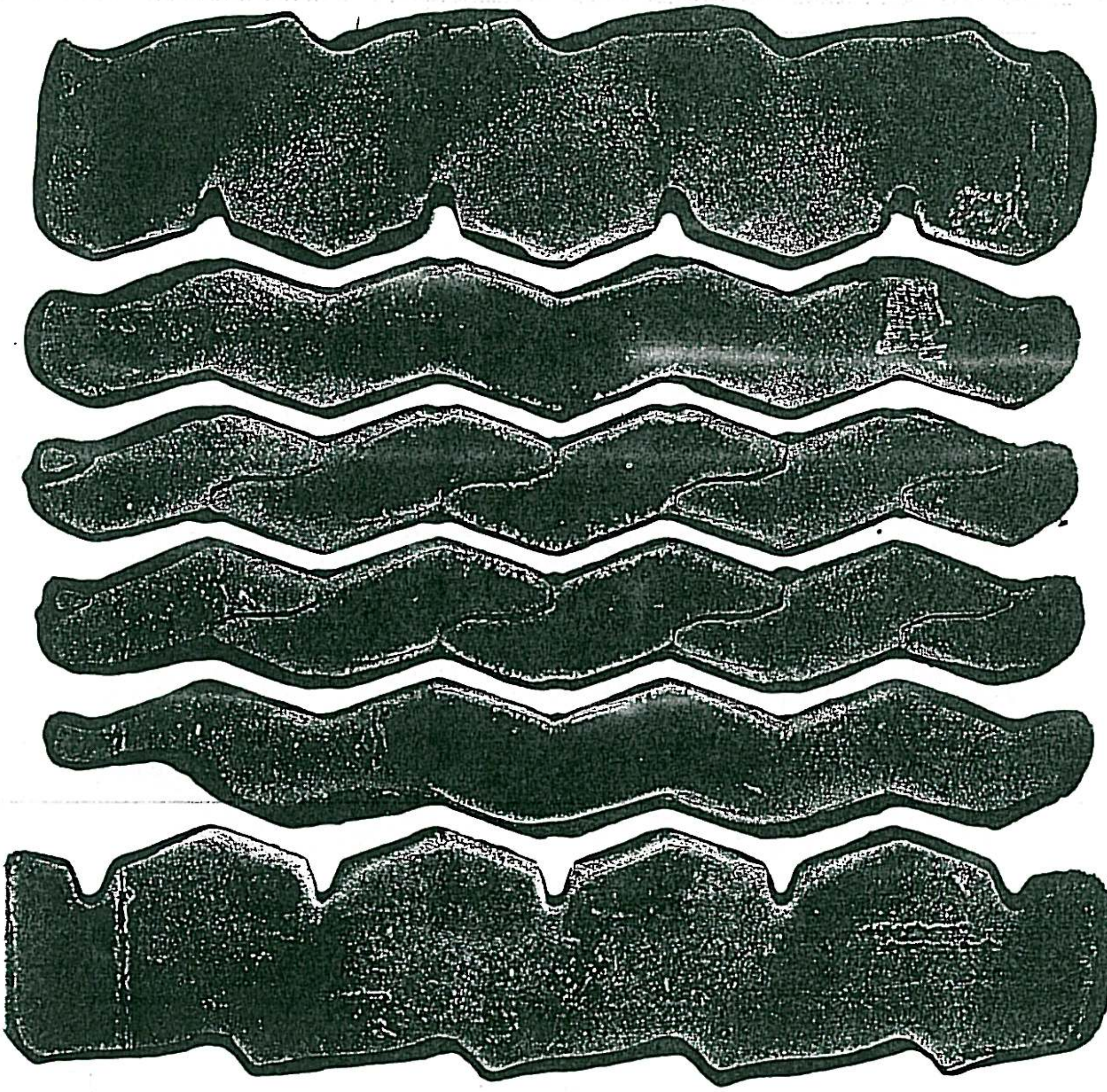


FIGURE D10

BRIDGESTONE (160AZ)
900KPa
75kN
RADIAL

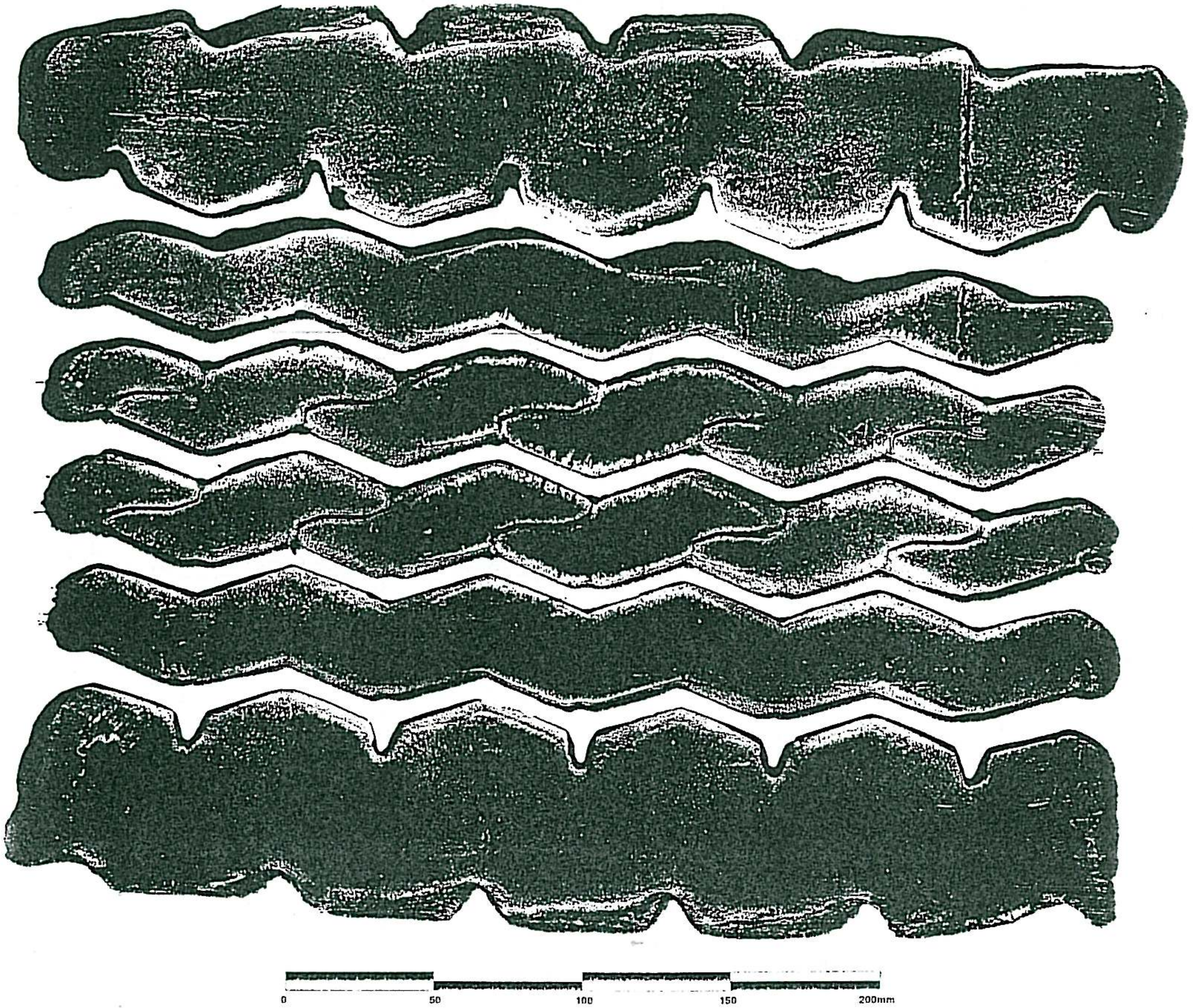


FIGURE D11

BRIDGESTONE (160AZ)
900KPa
100kN
RADIAL

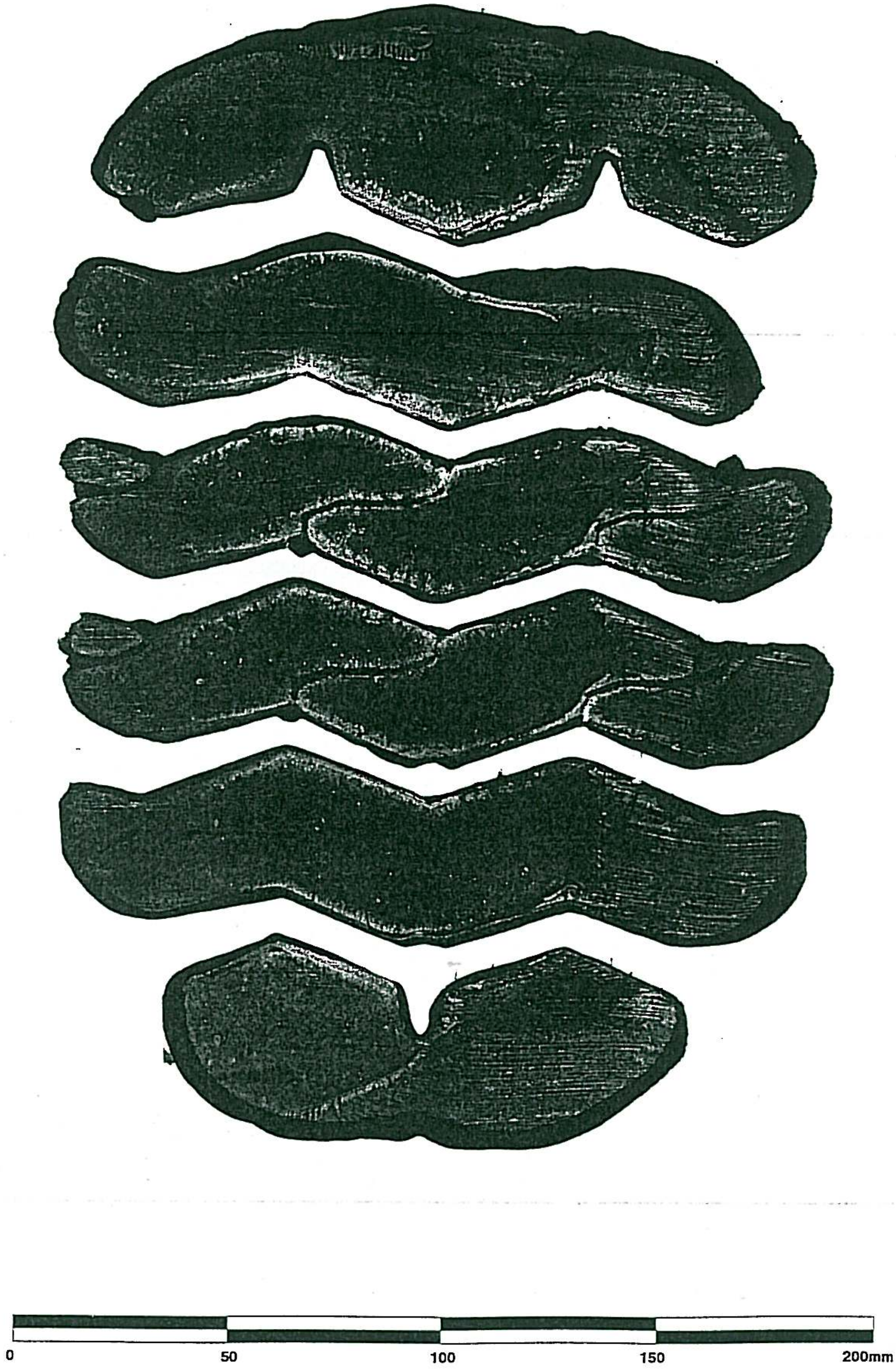


FIGURE D12

BRIDGESTONE (160AZ)
950KPa
25kN
RADIAL

FIGURE D13

BRIDGESTONE (160AZ)
950KPa
50kN
RADIAL

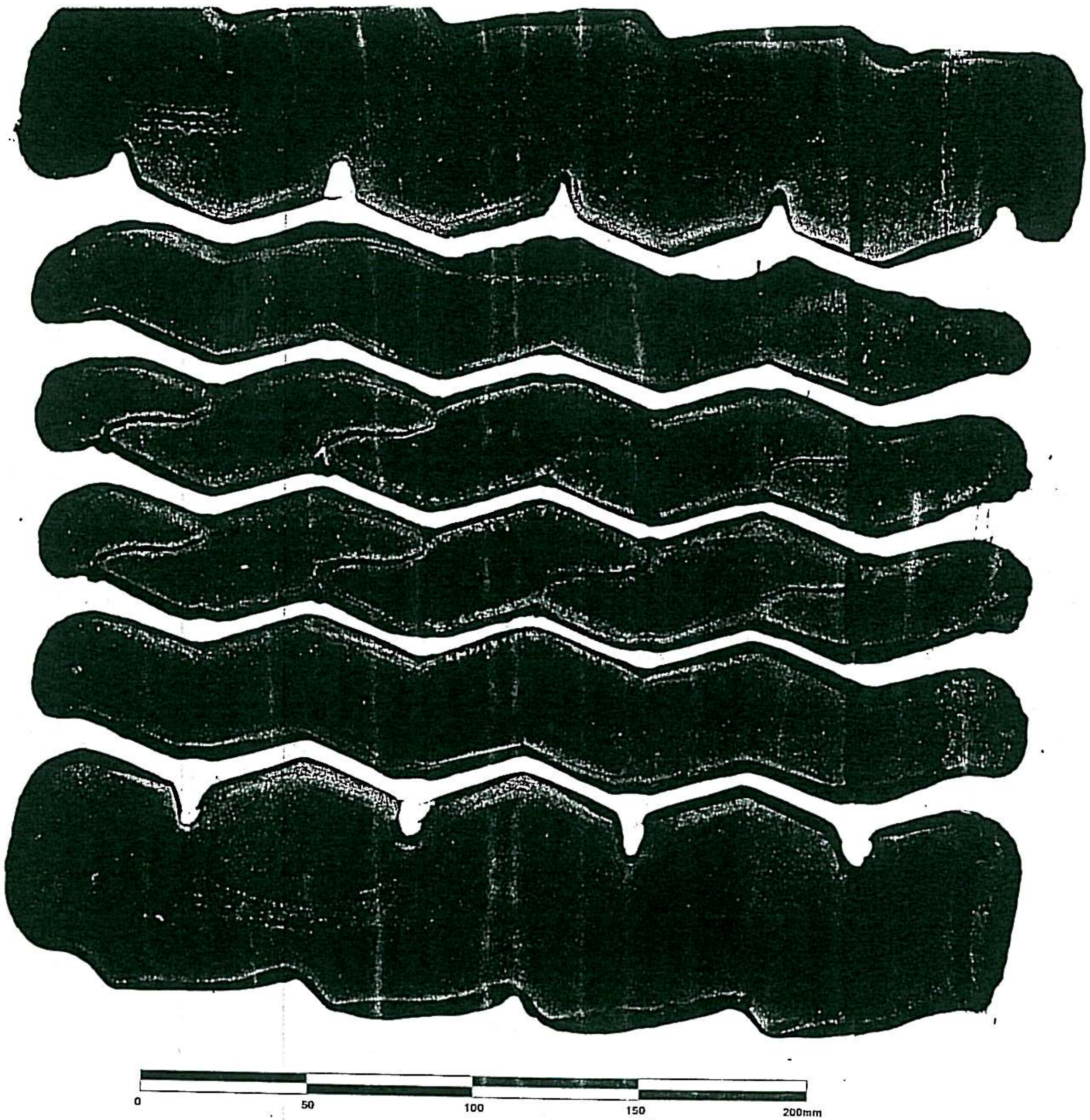


FIGURE D14

BRIDGESTONE (160AZ)
950KPa
75kN
RADIAL

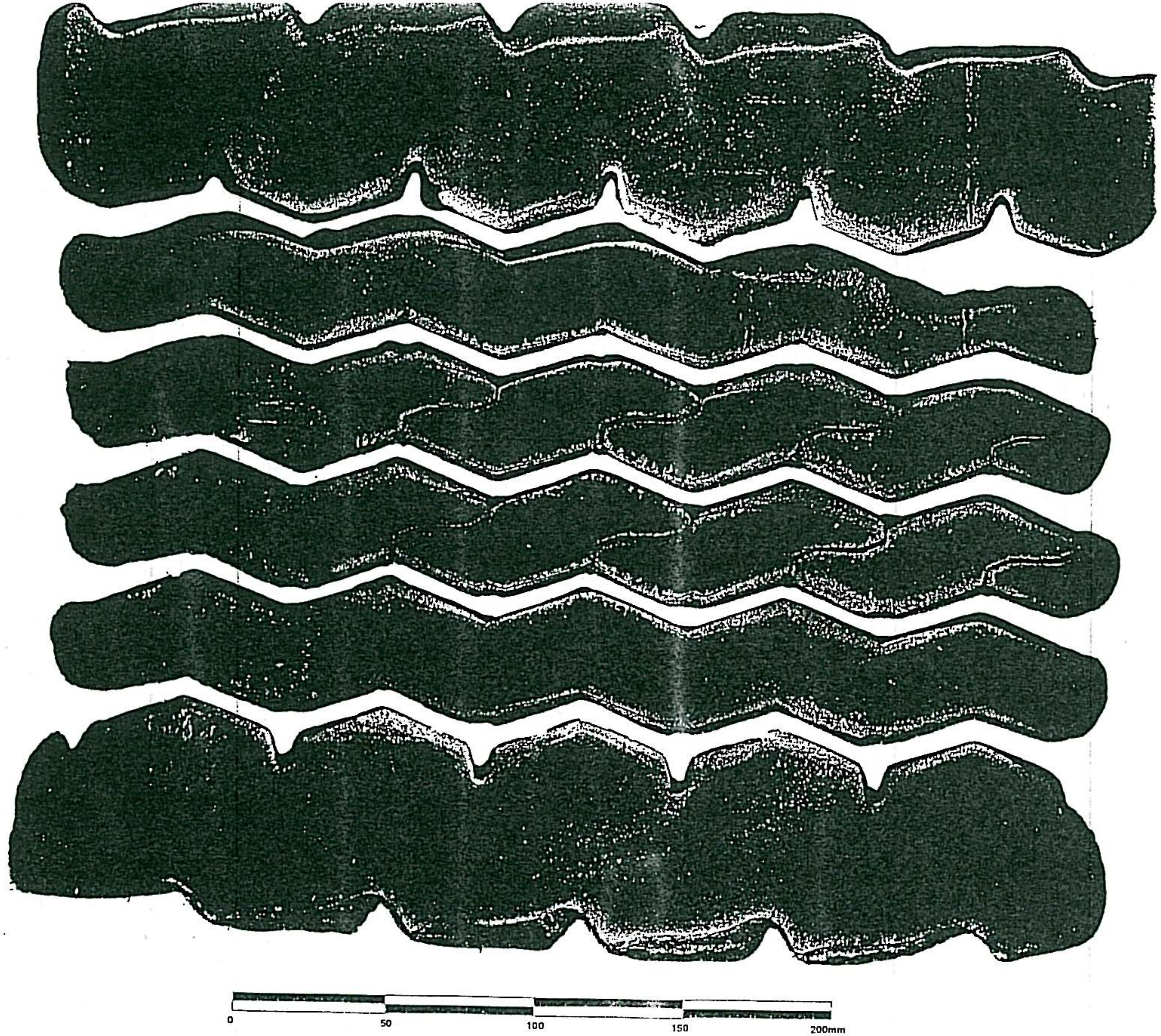


FIGURE D15

BRIDGESTONE (160AZ)
950KPa
100kN
RADIAL

FIGURE D16

BRIDGESTONE (160AZ)
1100KPa
25kN
RADIAL

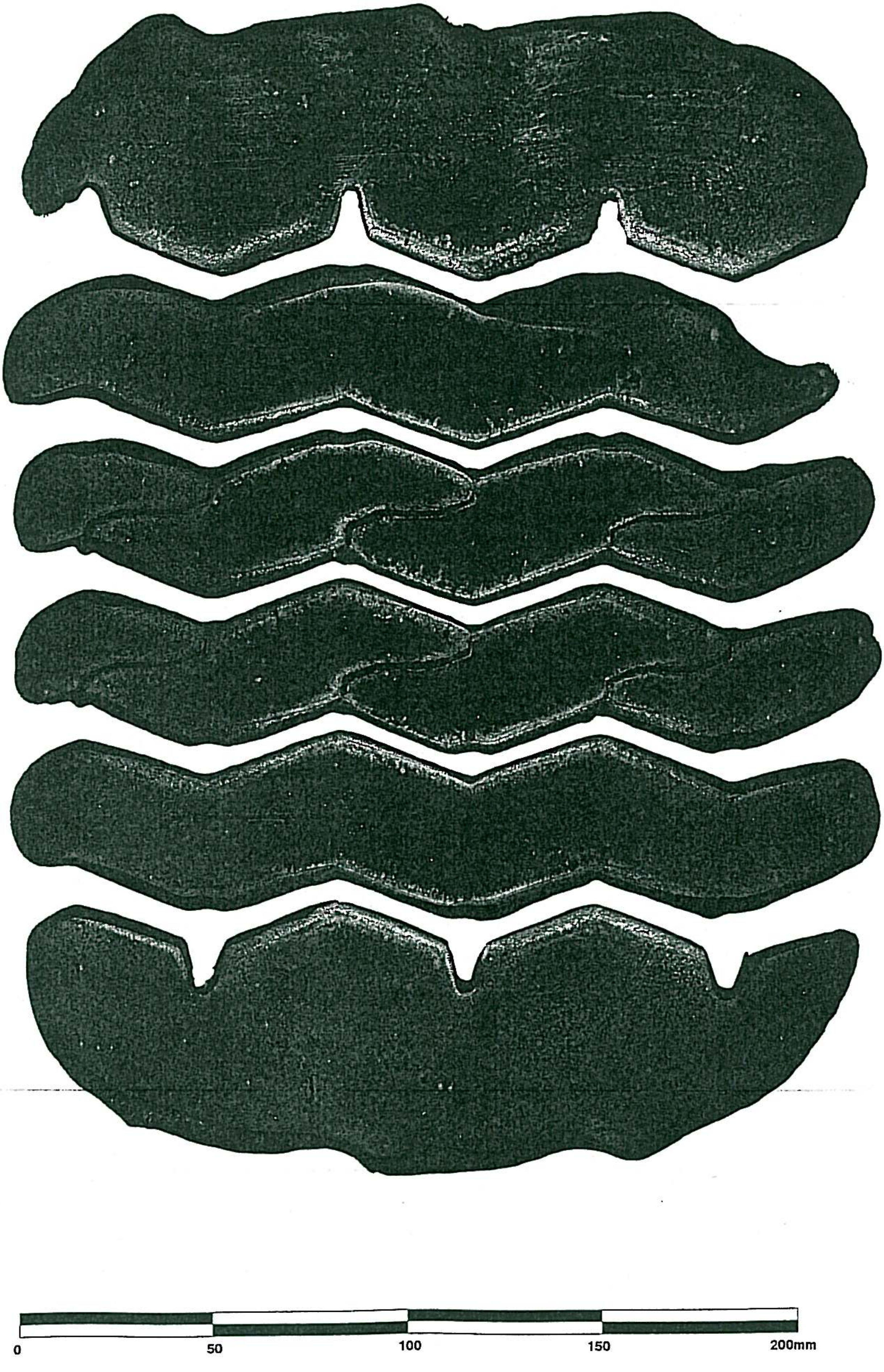


FIGURE D17

BRIDGESTONE (160AZ)
1100KPa
50kN
RADIAL

FIGURE D18

BRIDGESTONE (160AZ)
1100KPa
75kN
RADIAL

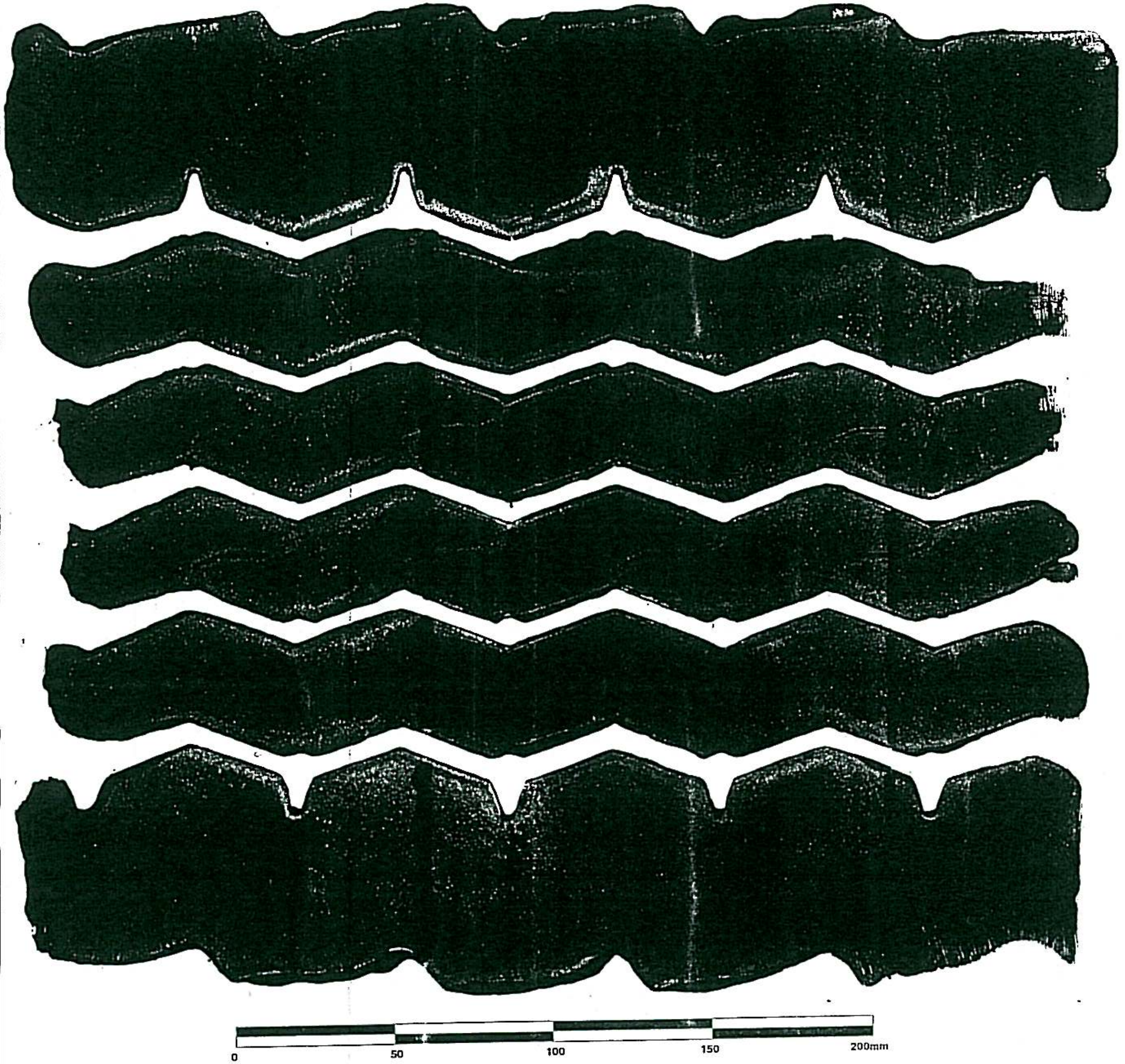


FIGURE D19

BRIDGESTONE (160AZ)
1100KPa
100kN
RADIAL

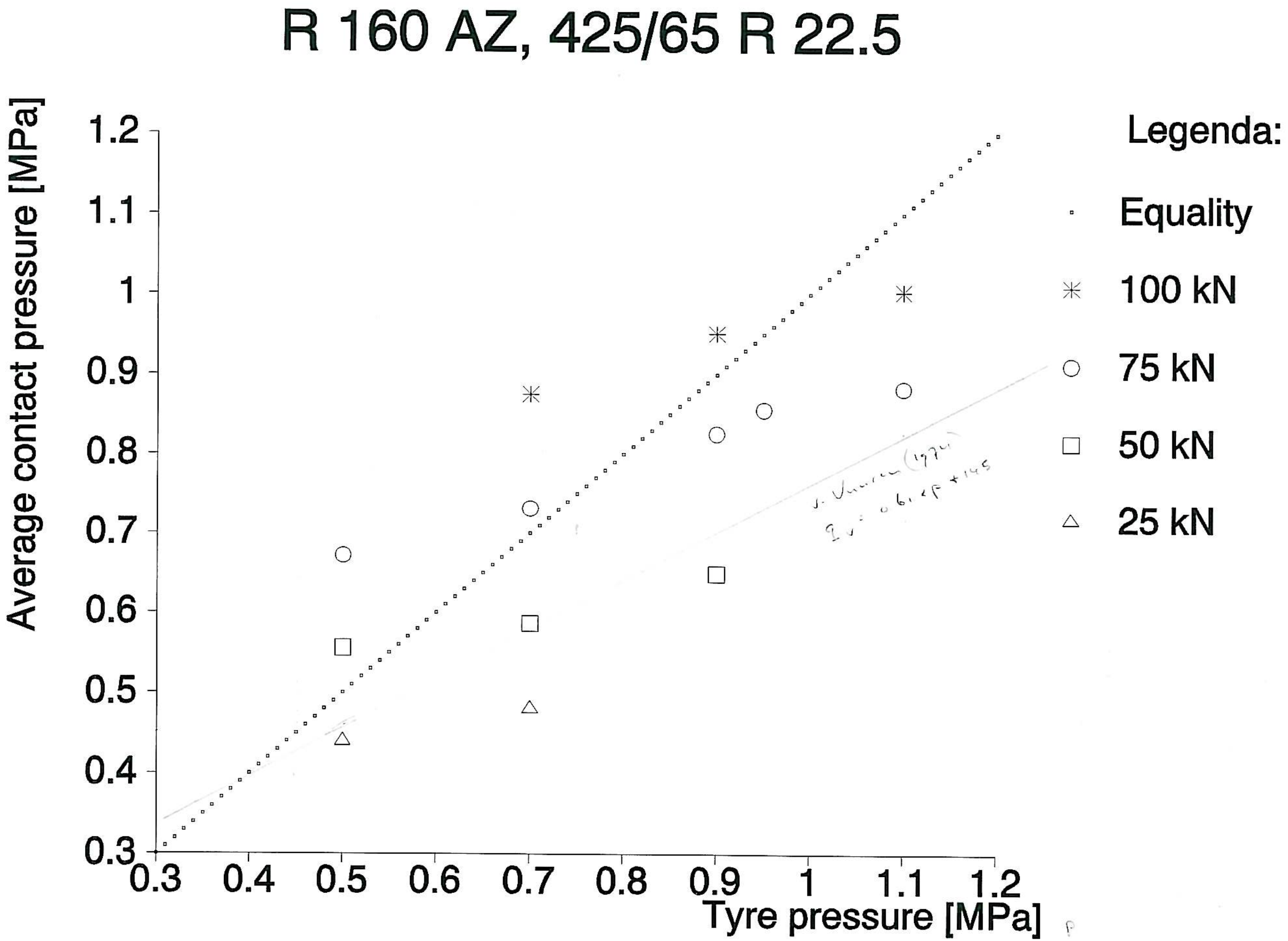
Tyre contact area Lintrack super single tyre
(Bridgestone V-steel Rib 160, R 160 AZ, 425/65 R 22.5, 16.5 R 22.5, Load range L, 20 PR)
Net area = gross area minus groove area

measured 1991/1992, after less than 300.000 loadcycles (groove width 15+13+13+13+15 mm)

load [kN]	inf.pres. [MPa]	gross width [mm]	length [mm]	shape	gross area [mm^2]	radius equiv. circle [mm]	average contact pressure [MPa]	net area [mm^2]	radius equiv. circle [mm]	average contact pressure [MPa]
25	0.5	295	220	ellips	62182	141	0.40	47002	122	0.53
25	0.7	280	197	ellips	51732	128	0.48	38139	110	0.66
25	0.9	280	190	ellips	49743	126	0.50	36633	108	0.68
50	0.7	300	285	rectangle	85500	165	0.58	65835	145	0.76
50	0.9	300	270	rectangle	81000	161	0.62	62370	141	0.80
75	0.95	300	270	rectangle	81000	161	0.93	62370	141	1.20

measured may 1995, after 4 million loadcycles (groove width 15+12+12+12+15 mm)
The length value was difficult to asses, as the tyre print had a ragged edge. All length values may be about 10 mm too long
The side edges of the tyre had worn away partly, reducing the width from 300 mm to an average of about 293 mm

load [kN]	inf.pres. [MPa]	gross width [mm]	length [mm]	shape	gross area [mm^2]	radius equiv. circle [mm]	average contact pressure [MPa]	net area [mm^2]	radius equiv. circle [mm]	average contact pressure [MPa]
25	0.5	290	220	ellips	56840	135	0.44	43640	118	0.57
25	0.7	283	203	ellips	52033	129	0.48	39955	113	0.63
50	0.5	293	307	rectangle	89951	169	0.56	69689	149	0.72
50	0.7	293	291	rectangle	85263	165	0.59	66057	145	0.76
50	0.9	294	262	rectangle	77028	157	0.65	59736	138	0.84
75	0.5	293	381	rectangle	111633	189	0.67	86487	166	0.87
75	0.7	293	350	rectangle	102550	181	0.73	79450	159	0.94
75	0.9	293	310	rectangle	90830	170	0.83	70370	150	1.07
75	0.95	294	298	rectangle	87612	167	0.86	67944	147	1.10
75	1.1	295	288	rectangle	84960	164	0.88	65952	145	1.14
100	0.7	293	390	rectangle	114270	191	0.88	88530	168	1.13
100	0.9	293	359	rectangle	105187	183	0.95	81493	161	1.23
100	1.1	295	338	rectangle	99710	178	1.00	77402	157	1.29


R 160 AZ, 425/65 R 22.5
Average contact pressure [MPa]
Tyre pressure [MPa]
Legenda:
Equality
100 kN
75 kN
50 kN
25 kN

APPENDIX E:

3-DIMENSIONAL (3-D) PLOTS OF STRESSES MEASURED UNDER THE LINTRACK *NEW* BRIDGESTONE 425/65 R 22.5 R164BZ TYRE AT "CREEP SPEED"

TABLE 2: HVS4: 3D Stress Sensor Tests on the New Bridgestone R164BZ 425/65 R22.5 PR20 tyre

CREEP TESTS

Legend of filename with tests on NEW tyre : NNSC52AZ.PRN :

N=Netherlands ; N=Lintrack New tyre ; S=Super single ; C=Creep speed;(or T=Traffic (HVS) speed) ;

5=Cold inflation pressure 500 kPa ; 2=Vertical load 25 kN : A=Test (repeat)1 (or B=repeat 2 or C=repeat 3);

Z=Vertical stress (or X=Transverse, or Y=Longitudinal).

DATE 16/07/96

Speed Sensor distance = 1.0m

NETNEW.WK1

HVS POSITION

Traffic side

Traffic side | Cabin end

Caravan side

Filename		PRESSURE	HVS	LOAD	TEMP	SPEED	Hz	Figure	Pin numbers across loadcell										A = ALL DIRECTIONS MISSED THE PIN										3d-Loadcell
*.prn		(kPa)	(kN)	Box (kN)	°C	(m/s)	(sam/sec)	no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total load (kN)
NNSC52	Az/x/y	500	25	23.4	20	0.309	150	E1	A																			A	26.02
NNSC52	Bz/x/y	500	25	23.4	20	0.318	150	-	A				A															A	24.50
NNSC52	Cz/x/y	500	25	23.4	20	0.320	150	-	A				A															A	25.74
NNSC55	Az/x/y	500	50	49.5	20	0.298	150	E2	A																			A	52.56
NNSC55	Bz/x/y	500	50	49.5	20	0.297	150	-	A																			A	52.50
NNSC55	Cz/x/y	500	50	49.5	20	0.297	150	-					A					A										A	50.27
NNSC57	Az/x/y	500	75	75.4	20	0.286	150	E3					A					A					A				A	A	73.21
NNSC57	Bz/x/y	500	75	75.4	20	0.289	150	-					A					A					A					A	74.12
NNSC57	Cz/x/y	500	75	75.4	20	0.292	150	-					A					A					A					A	76.01
NNSC72	Az/x/y	700	25	24.0	20	0.314	150	E4	A				A								A							A	23.96
NNSC72	Bz/x/y	700	25	24.1	20	0.327	150	-	A																			A	25.61
NNSC72	Cz/x/y	700	25	24.3	20	0.324	150	-	A												A							A	25.34
NNSC75	Az/x/y	700	50	49.8	20	0.296	150	E5																				A	50.25
NNSC75	Bz/x/y	700	50	49.6	20	0.301	150	-	A																			A	51.86
NNSC75	Cz/x/y	700	50	49.8	20	0.298	150	-	A																			A	52.13
NNSC77	Az/x/y	700	75	74.8	20	0.287	150	E6					A															A	74.90
NNSC77	Bz/x/y	700	75	74.8	20	0.290	150	-																				A	75.98
NNSC77	Cz/x/y	700	75	74.8	20	0.292	150	-																				A	77.68
NNSC71	Az/x/y	700	100	99.3	19	0.290	150	E7					A															A	105.68
NNSC71	Bz/x/y	700	100	99.8	19	0.291	150	-					A															A	102.90
NNSC71	Cz/x/y	700	100	99.3	19	0.291	150	-																				A	111.48
NNC902	Az/x/y	900	25	22.7	15	0.297	150	E8	A												A							A	23.68
NNC902	Bz/x/y	900	25	22.7	15	0.298	150	-	A							A					A							A	22.74
NNC902	Cz/x/y	900	25	22.7	15	0.307	150	-	A												A							A	23.94
NNC905	Az/x/y	900	50	49.1	16	0.293	150	E9	A							A												A	50.15
NNC905	Bz/x/y	900	50	49.1	16	0.263	150	-	A												A							A	55.28
NNC905	Cz/x/y	900	50	49.1	16	0.297	150	-	A												A							A	50.78
NNC907	Az/x/y	900	75	74.3	18	0.289	150	E10																				A	77.70
NNC907	Bz/x/y	900	75	74.3	18	0.287	150	-	A																			A	79.59
NNC907	Cz/x/y	900	75	74.3	18	0.286	150	-	A																			A	79.35
NNC901	Az/x/y	900	100	99.8	18	0.284	150	E11	A																			A	104.50
NNC901	Bz/x/y	900	100	99.8	18	0.289	150	-	A																			A	101.53
NNC901	Cz/x/y	900	100	99.8	18	0.285	150	-	A																			A	99.89

TABLE 2 (Cont.): HVS4: 3D Stress Sensor Tests on the New Bridgestone R164BZ 425/65 R22.5 PR20 tyre

CREEP TESTS

Legend of filename with tests on NEW tyre : NNSC52AZ.PRN :

N=Netherlands ; N=Lintrack New tyre ; S=Super single ; C=Creep speed;(or T=Traffic (HVS) speed) ;

5=Cold inflation pressure 500 kPa ; 2=Vertical load 25 kN : A=Test (repeat)1 (or B=repeat 2 or C=repeat 3);

Z=Vertical stress (or X=Transverse, or Y=Longitudinal).

DATE 16/07/96

Speed Sensor distance = 1.0m

NETNEW.WK1

HVS POSITION

Traffic side

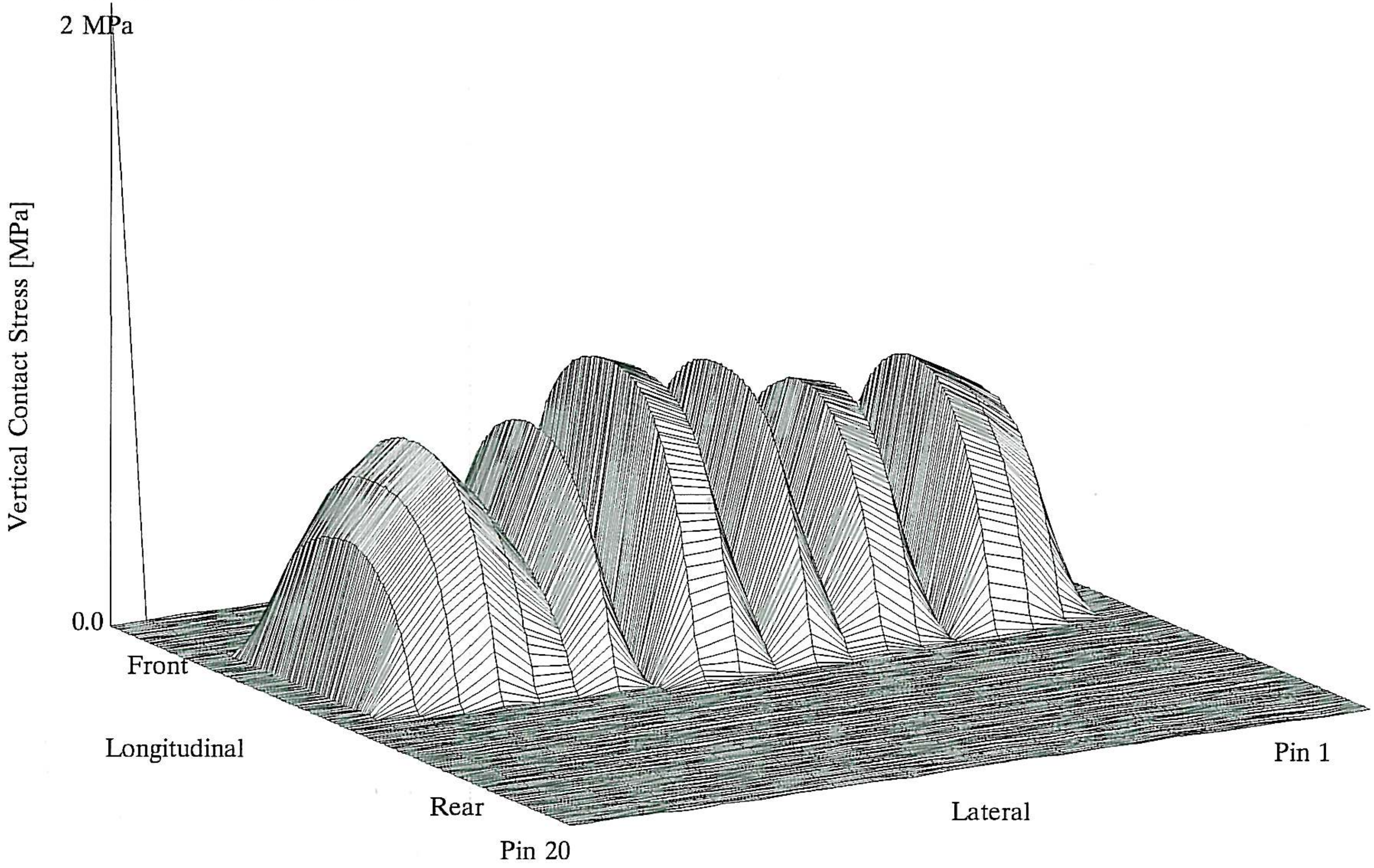
Traffic side | Cabin end

Caravan side

Filename *.prn		PRESSURE (kPa)	HVS (kN)	LOAD Box (kN)	TEMP °C	SPEED (m/s)	Hz (sam/sec)	Figure no.	Pin numbers across loadcell A = ALL DIRECTIONS MISSED THE PIN																				3d-Loadcell Total load (kN)
									1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
NNSC92	Az/x/y	950	25	24.8	22	0.307	150	E12	A																			A	25.07
NNSC92	Bz/x/y	950	25	24.8	22	0.310	150	-	A																			A	26.31
NNSC92	Cz/x/y	950	25	24.8	22	0.301	150	-	A															A				A	26.03
NNSC95	Az/x/y	950	50	47.1	21	0.289	150	E13	A												A							A	50.64
NNSC95	Bz/x/y	950	50	47.1	21	0.297	150	-	A																			A	50.73
NNSC95	Cz/x/y	950	50	47.1	21	0.300	150	-	A																			A	51.06
NNSC97	Az/x/y	950	75	73.7	20	0.289	150	E14																				A	79.88
NNSC97	Bz/x/y	950	75	73.7	20	0.289	150	-																				A	77.47
NNSC97	Cz/x/y	950	75	73.7	20	0.292	150	-	A				A															A	73.85
NNSC91	Az/x/y	950	100	100.4	21	0.277	150	E15																				A	107.41
NNSC91	Bz/x/y	950	100	100.0	21	0.275	150	-	A																			A	107.51
NNSC91	Cz/x/y	950	100	100.1	21	0.279	150	-	A																			A	107.78
NNSC12	Az/x/y	1100	25	22.0	17	0.296	150	E16	A																		A	A	22.27
NNSC12	Bz/x/y	1100	25	22.0	17	0.305	150	-	A												A						A	A	22.51
NNSC12	Cz/x/y	1100	25	24.5	17	0.293	150	-	A				A														A	A	24.95
NNSC15	Az/x/y	1100	50	49.0	18	0.288	150	E17	A																			A	49.80
NNSC15	Bz/x/y	1100	50	49.0	18	0.287	150	-	A																			A	49.19
NNSC15	Cz/x/y	1100	50	49.0	18	0.283	150	-	A																			A	50.20
NNSC17	Az/x/y	1100	75	74.1	19	0.285	150	E18																				A	78.21
NNSC17	Bz/x/y	1100	75	74.1	19	0.284	150	-	A																			A	74.81
NNSC17	Cz/x/y	1100	75	74.1	19	0.281	150	-	A																			A	72.29
NNSC11	Az/x/y	1100	100	100.1	20	0.284	150	E19																				A	100.21
NNSC11	Bz/x/y	1100	100	100.1	20	0.281	150	-																				A	96.97
NNSC11	Cz/x/y	1100	100	100.1	20	0.283	150	-					A															A	96.67

Applied Vertical Load (HVS) = 25 kN
Measured Vertical Load = 26.06 kN
Max. Stress = 0.9167 MPa

Inflation Press. = 500 kPa
Temperature = 20 deg.C
Wheel Speed = 0.309 m/s



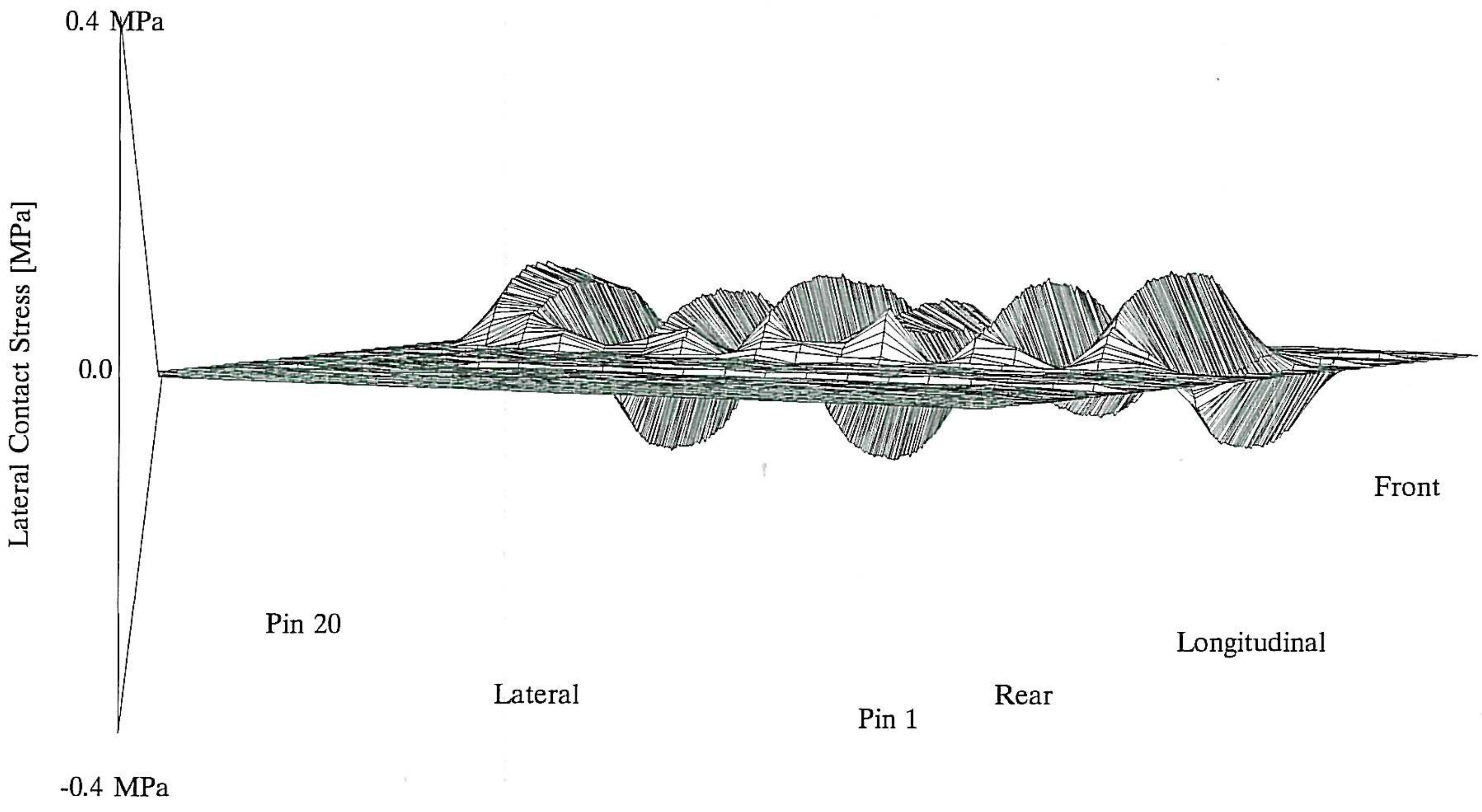
New Bridgestone 425/65R22.5 R164BZ

Filename : nnsc52az

FIGURE E1Z

Applied Vertical Load (HVS) = 25 kN
Measured Lateral Load = 0.4022 kN
Max. Stress = 0.1044 MPa
Min. Stress = -0.1213 MPa

Inflation Press. = 500 kPa
Temperature = 20 deg.C
Wheel Speed = 0.309 m/s



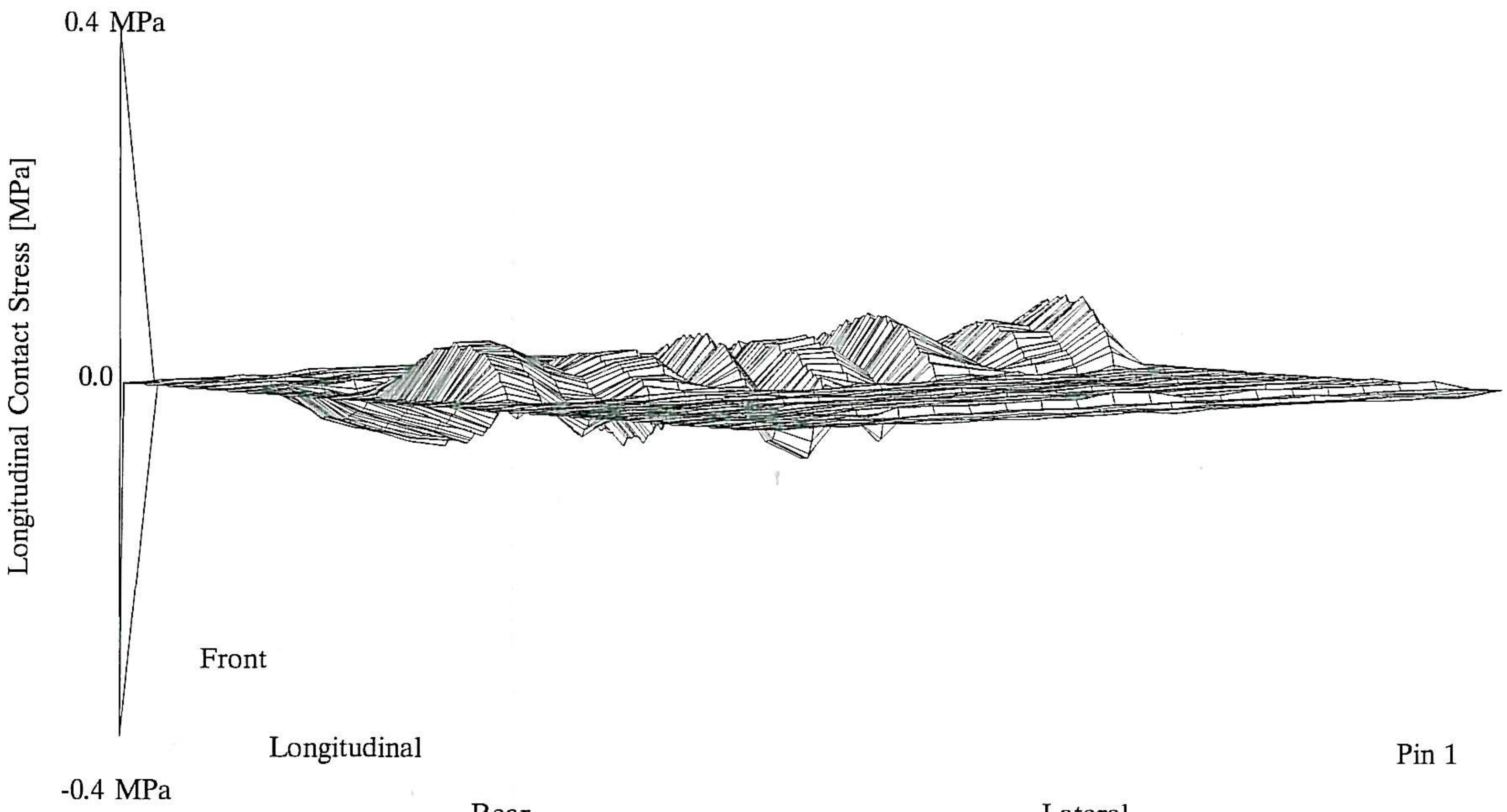
Filename : nnsc52ay

New Bridgestone 425/65R22.5 R164BZ

FIGURE E1Y

Applied Vertical Load (HVS) = 25 kN
Measured Longitudinal Load = 0.1946 kN
Max. Stress = 0.08323 MPa
Min. Stress = -0.08067 MPa

Inflation Press. = 500 kPa
Temperature = 20 deg.C
Wheel Speed = 0.309 m/s



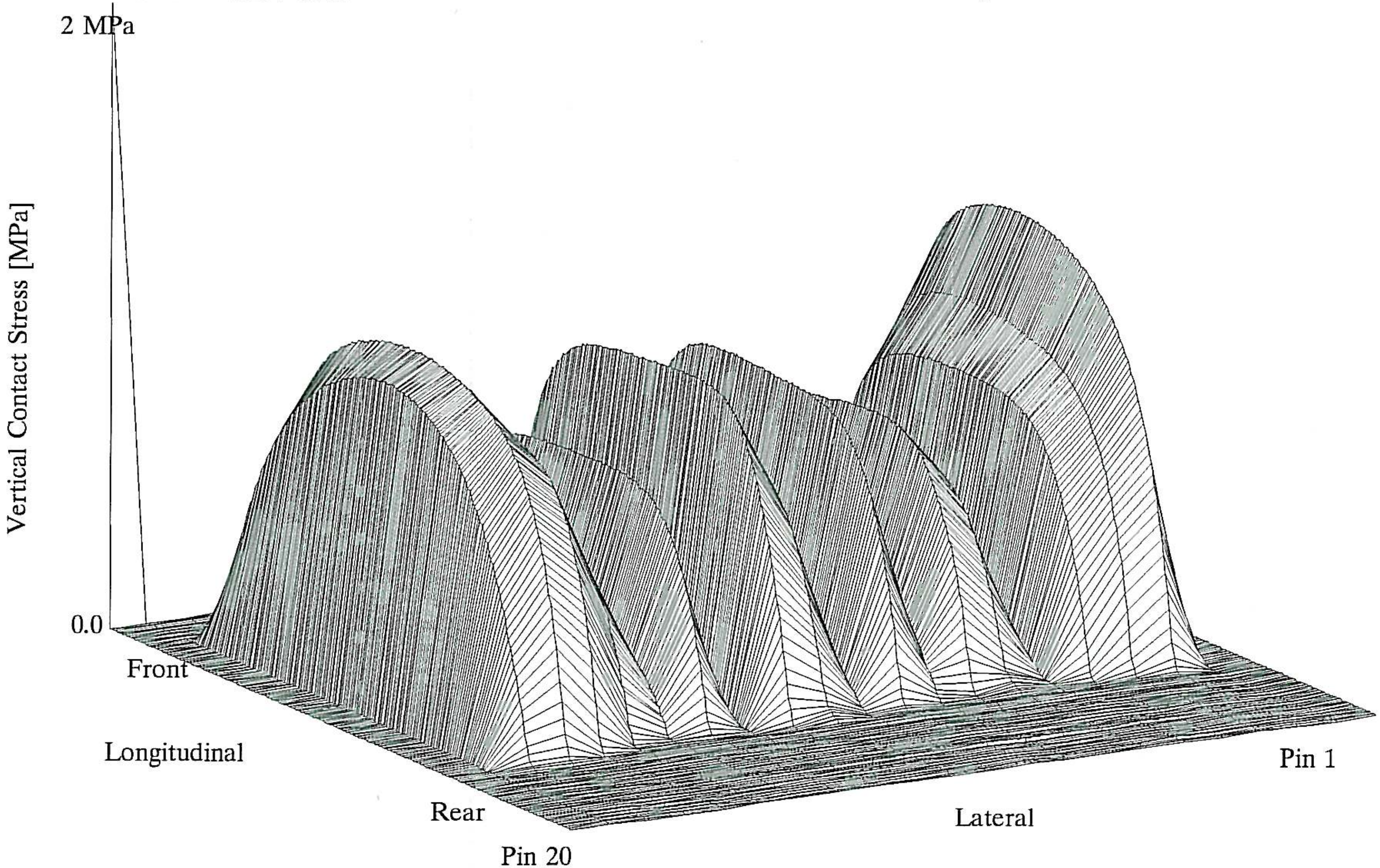
New Bridgestone 425/65R22.5 R164BZ

FIGURE E1X

Filename : nnsc52ax

Applied Vertical Load (HVS) = 50 kN
Measured Vertical Load = 52.54 kN
Max. Stress = 1.257 MPa

Inflation Press. = 500 kPa
Temperature = 20 deg.C
Wheel Speed = 0.298 m/s



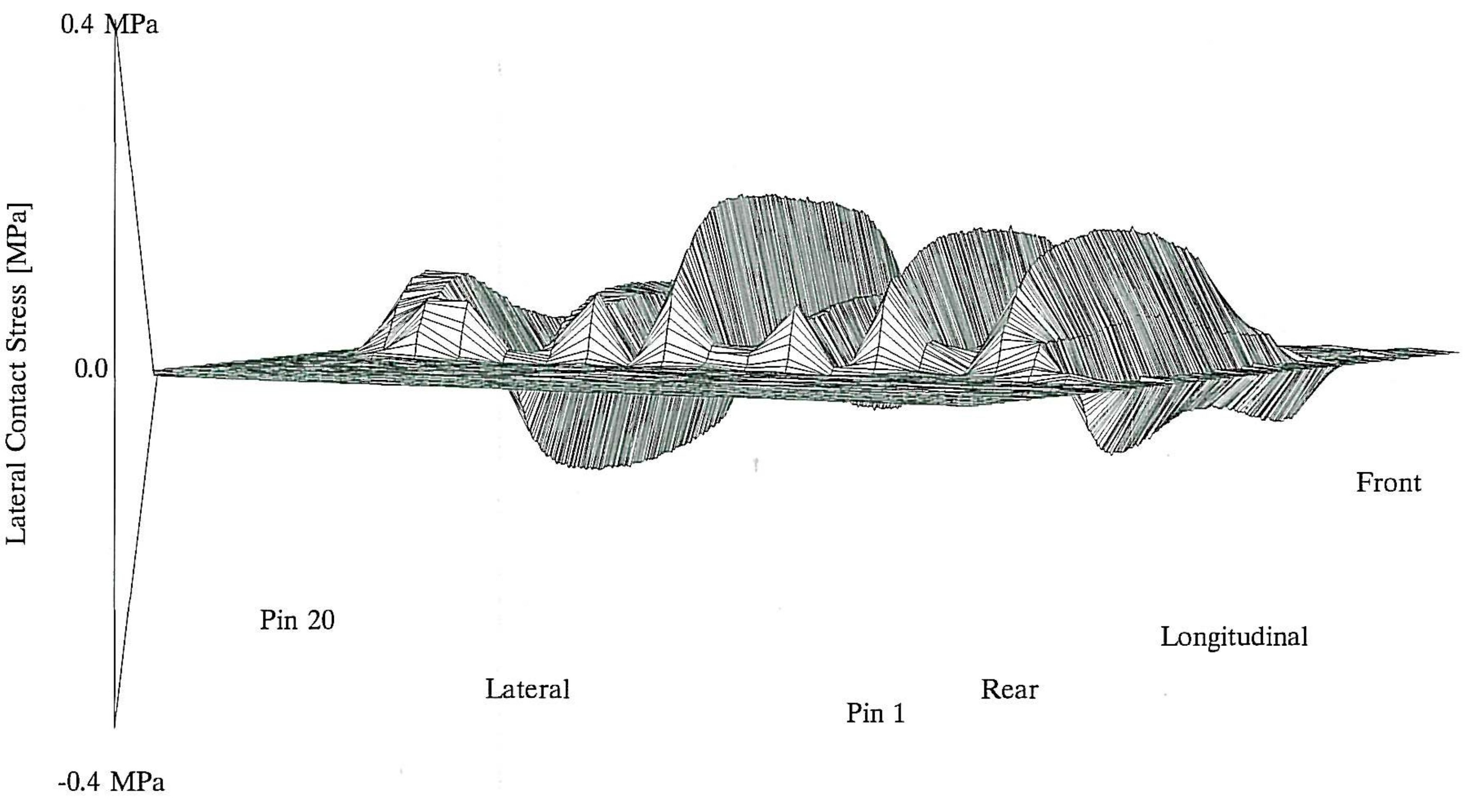
New Bridgestone 425/65R22.5 R164BZ

Filename : nnsc55az

FIGURE E2Z

Applied Vertical Load (HVS) = 50 kN
Measured Lateral Load = 2.525 kN
Max. Stress = 0.1871 MPa
Min. Stress = -0.1336 MPa

Inflation Press. = 500 kPa
Temperature = 20 deg.C
Wheel Speed = 0.298 m/s



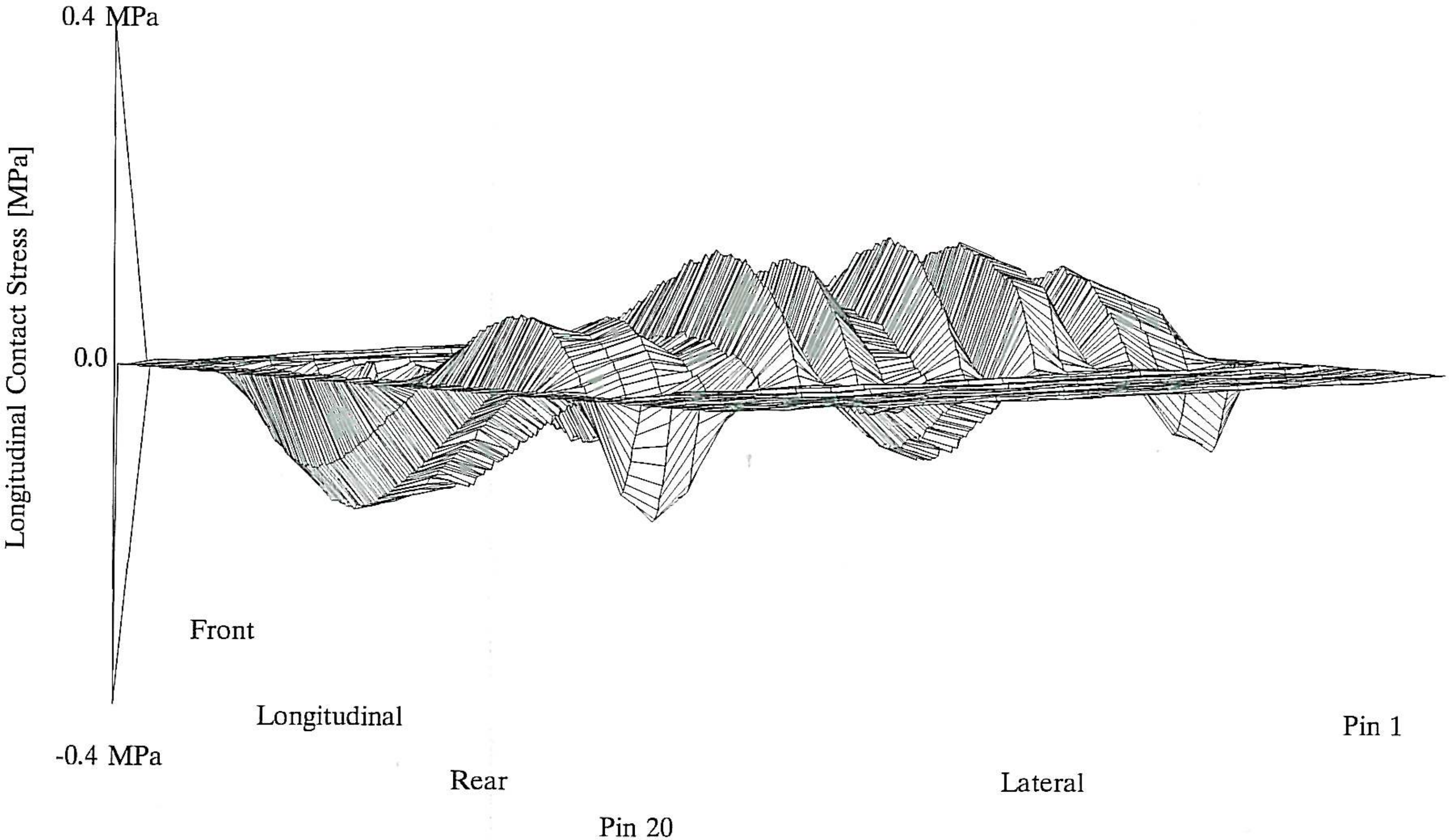
New Bridgestone 425/65R22.5 R164BZ

Filename : nnsc55ay

FIGURE E2Y

Applied Vertical Load (HVS) = 50 kN
Measured Longitudinal Load = -0.09078 kN
Max. Stress = 0.1583 MPa
Min. Stress = -0.1647 MPa

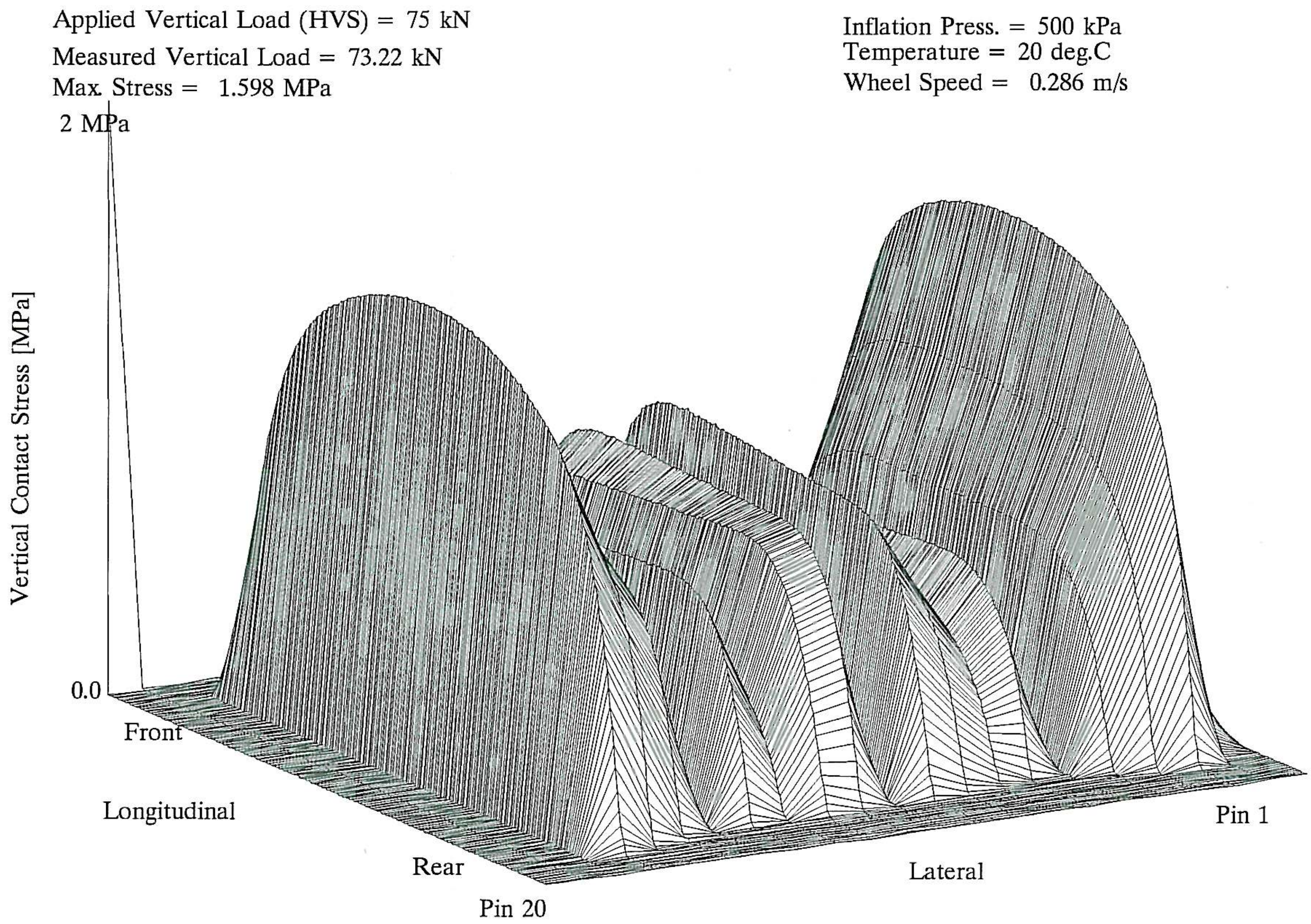
Inflation Press. = 500 kPa
Temperature = 20 deg.C
Wheel Speed = 0.298 m/s



New Bridgestone 425/65R22.5 R164BZ

Filename : nnsc55ax

FIGURE E2X



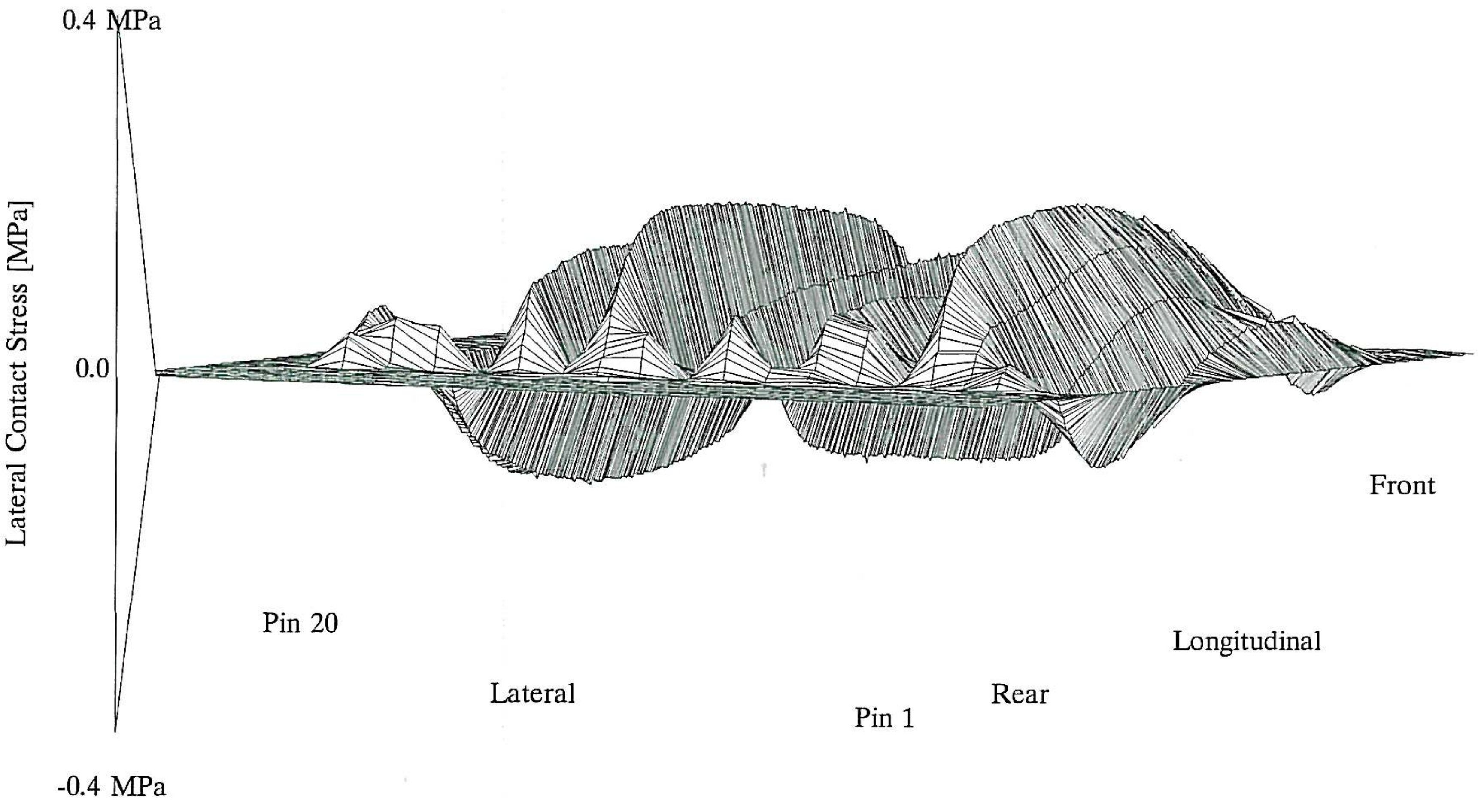
New Bridgestone 425/65R22.5 R164BZ

Filename : nnsc57az

FIGURE E3Z

Applied Vertical Load (HVS) = 75 kN
Measured Lateral Load = 1.757 kN
Max. Stress = 0.1883 MPa
Min. Stress = -0.1463 MPa

Inflation Press. = 500 kPa
Temperature = 20 deg.C
Wheel Speed = 0.286 m/s



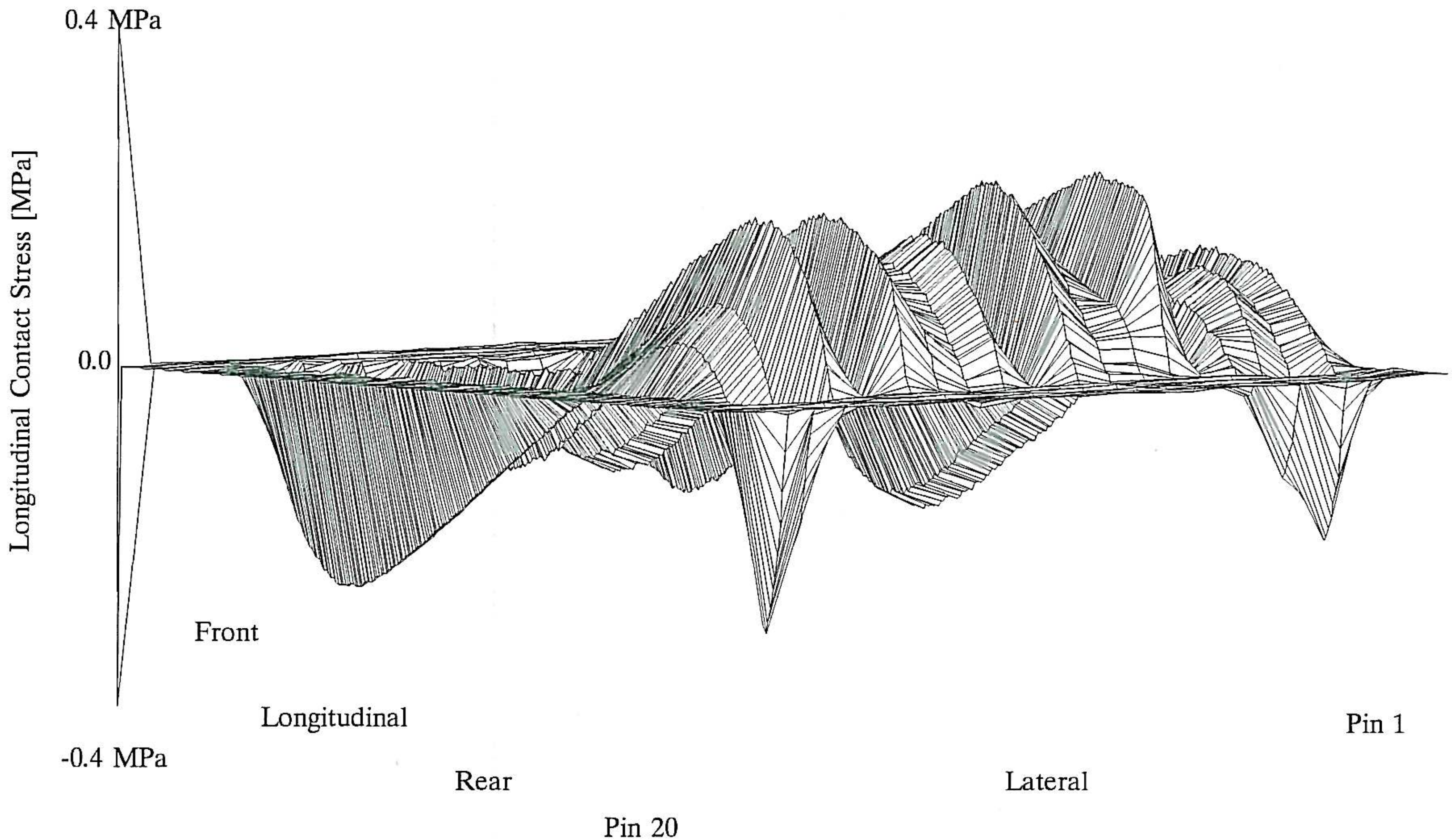
Filename : nnsc57ay

New Bridgestone 425/65R22.5 R164BZ

FIGURE E3Y

Applied Vertical Load (HVS) = 75 kN
Measured Longitudinal Load = 0.64 kN
Max. Stress = 0.2385 MPa
Min. Stress = -0.2726 MPa

Inflation Press. = 500 kPa
Temperature = 20 deg.C
Wheel Speed = 0.286 m/s



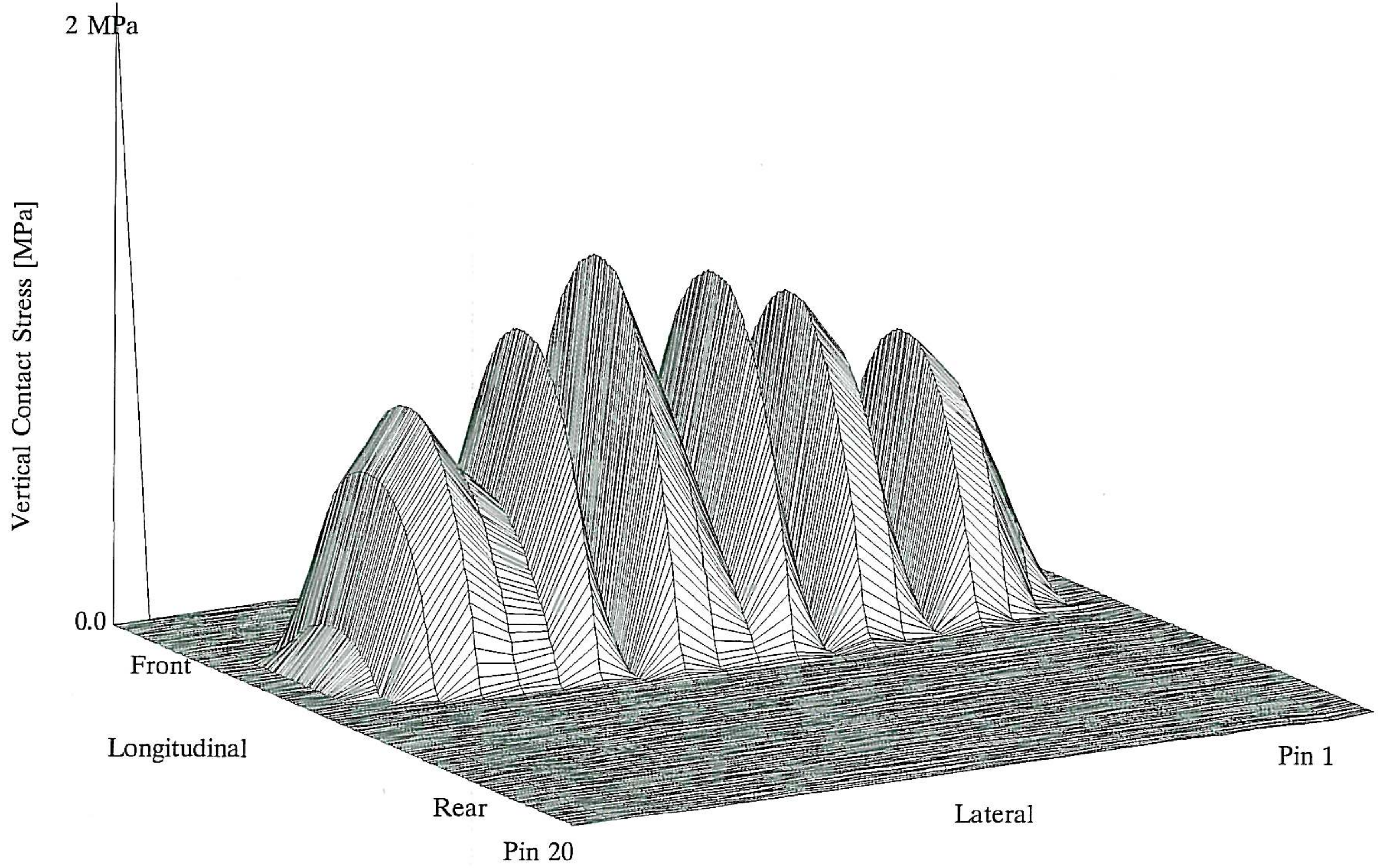
New Bridgestone 425/65R22.5 R164BZ

FIGURE E3X

Filename : nnsc57ax

Applied Vertical Load (HVS) = 25 kN
Measured Vertical Load = 23.78 kN
Max. Stress = 1.233 MPa

Inflation Press. = 700 kPa
Temperature = 20 deg.C
Wheel Speed = 0.314 m/s



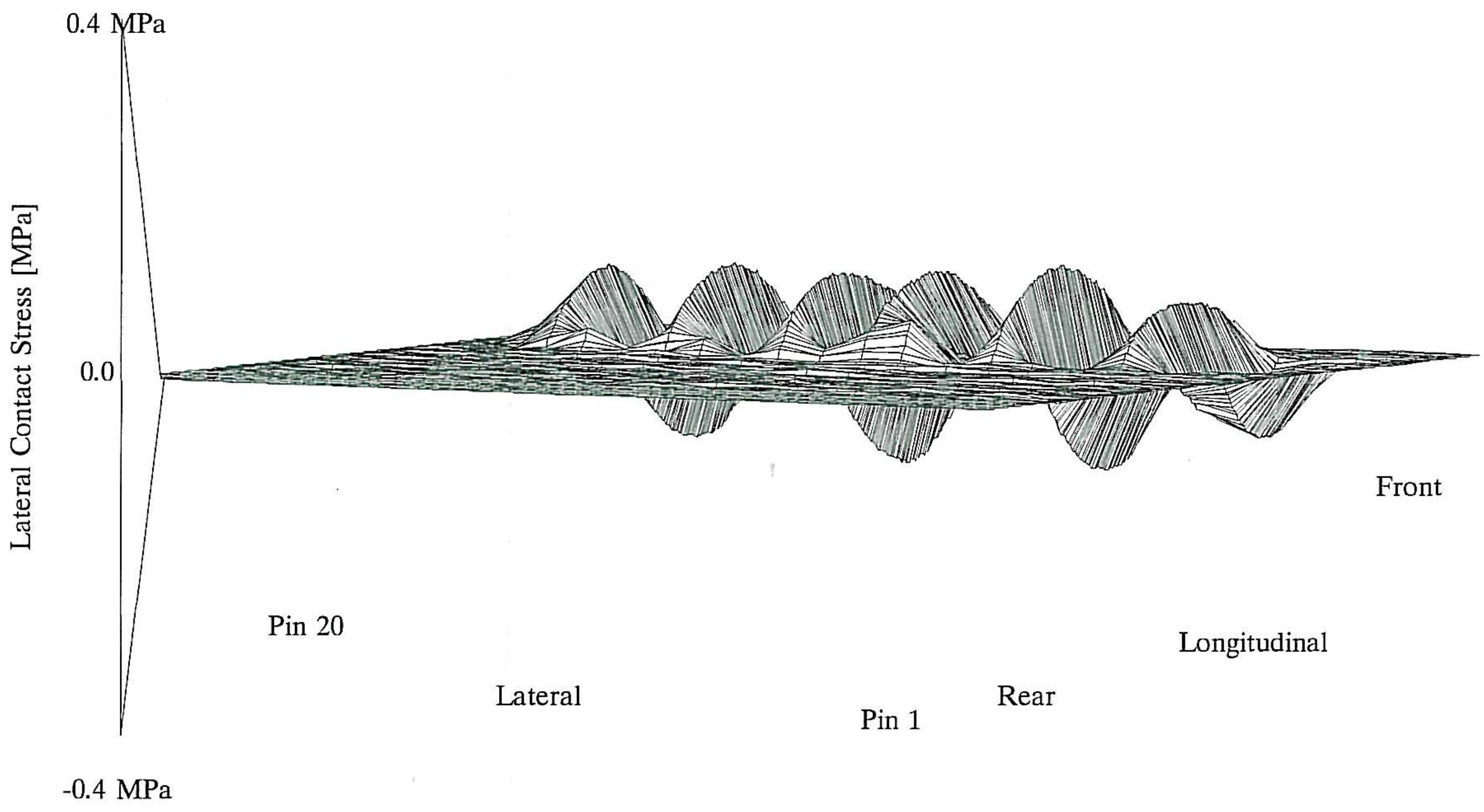
New Bridgestone 425/65R22.5 R164BZ

FIGURE E4Z

Filename : nnsc72az

Applied Vertical Load (HVS) = 25 kN
Measured Lateral Load = 0.02382 kN
Max. Stress = 0.1048 MPa
Min. Stress = -0.1239 MPa

Inflation Press. = 700 kPa
Temperature = 20 deg.C
Wheel Speed = 0.314 m/s



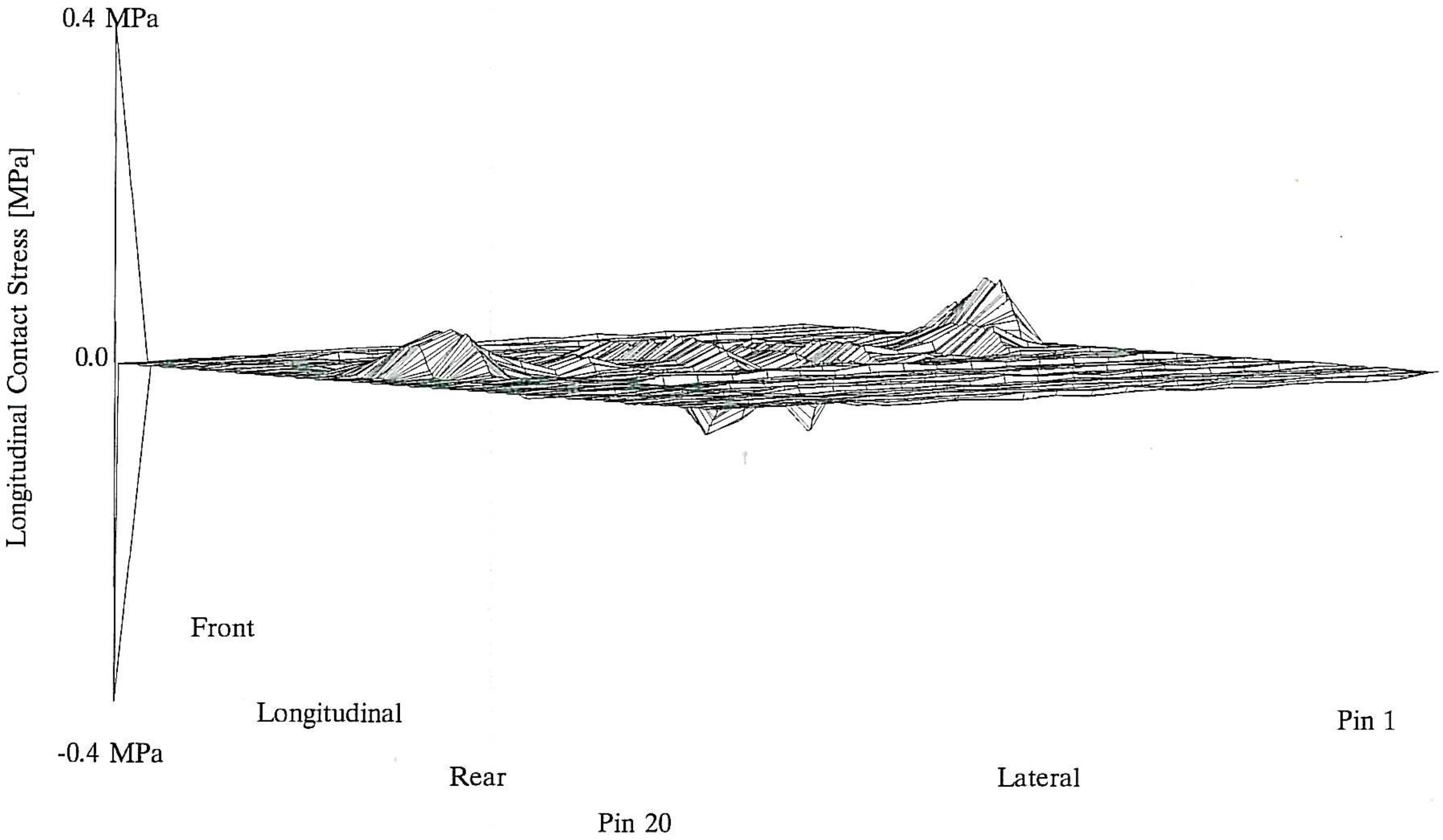
Filename : nnsc72ay

New Bridgestone 425/65R22.5 R164BZ

FIGURE E4Y

Applied Vertical Load (HVS) = 25 kN
Measured Longitudinal Load = -0.2585 kN
Max. Stress = 0.08099 MPa
Min. Stress = -0.07895 MPa

Inflation Press. = 700 kPa
Temperature = 20 deg.C
Wheel Speed = 0.314 m/s



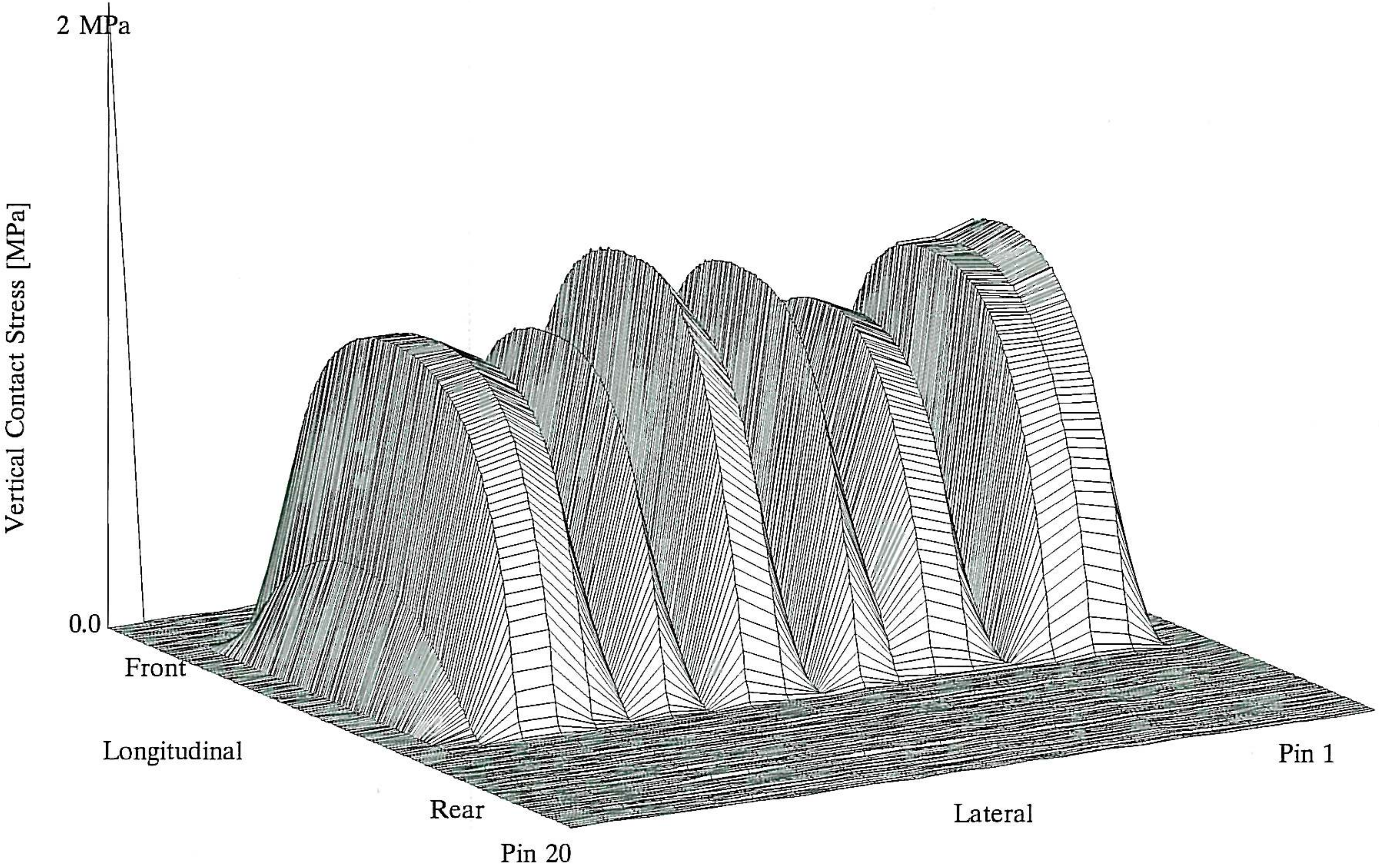
New Bridgestone 425/65R22.5 R164BZ

Filename : nnsc72ax

FIGURE E4X

Applied Vertical Load (HVS) = 50 kN
Measured Vertical Load = 50.19 kN
Max. Stress = 1.285 MPa

Inflation Press. = 700 kPa
Temperature = 20 deg.C
Wheel Speed = 0.296 m/s



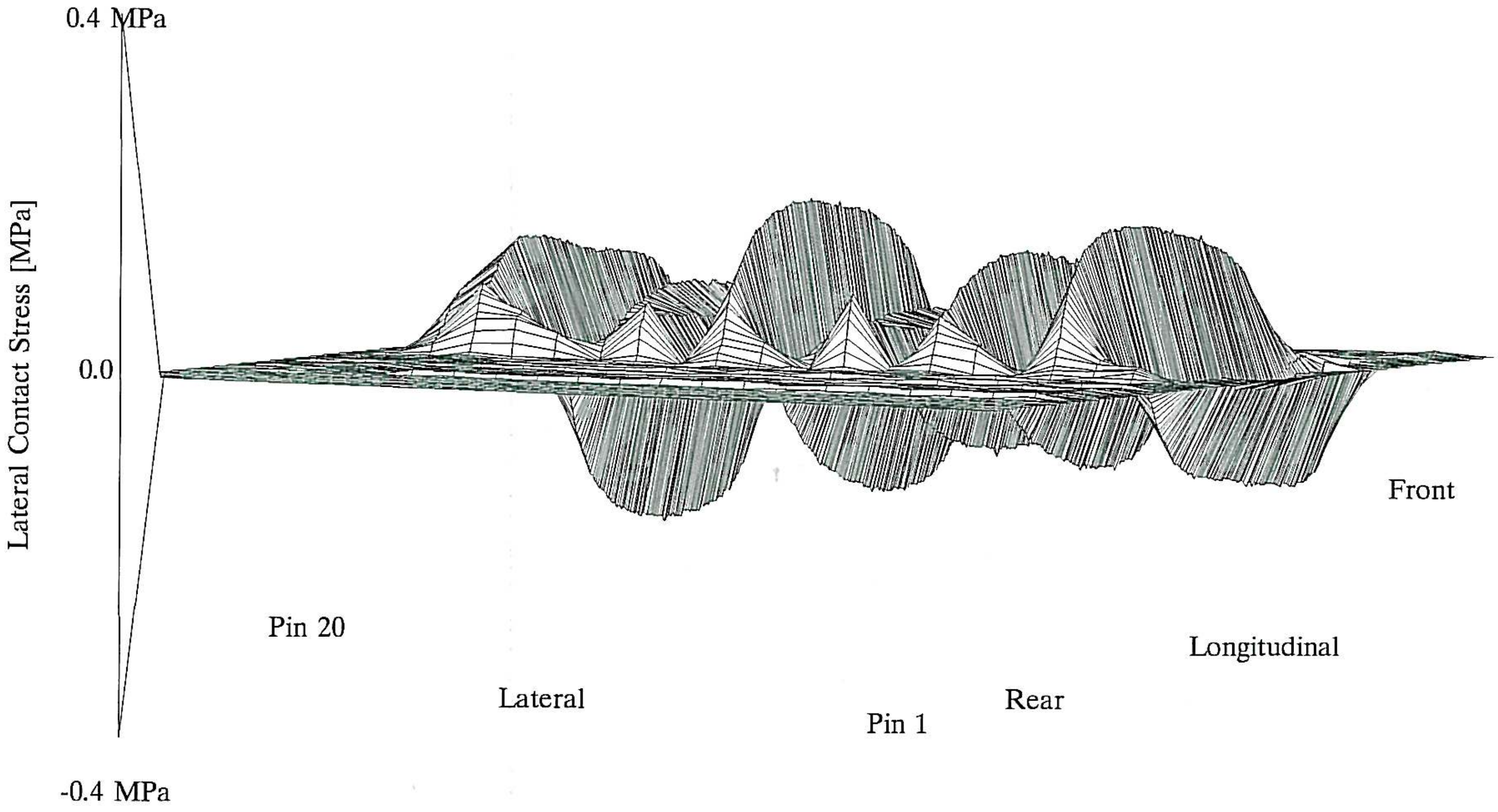
New Bridgestone 425/65R22.5 R164BZ

Filename : nnsc75az

FIGURE E5Z

Applied Vertical Load (HVS) = 50 kN
Measured Lateral Load = 0.6592 kN
Max. Stress = 0.1763 MPa
Min. Stress = -0.191 MPa

Inflation Press. = 700 kPa
Temperature = 20 deg.C
Wheel Speed = 0.296 m/s



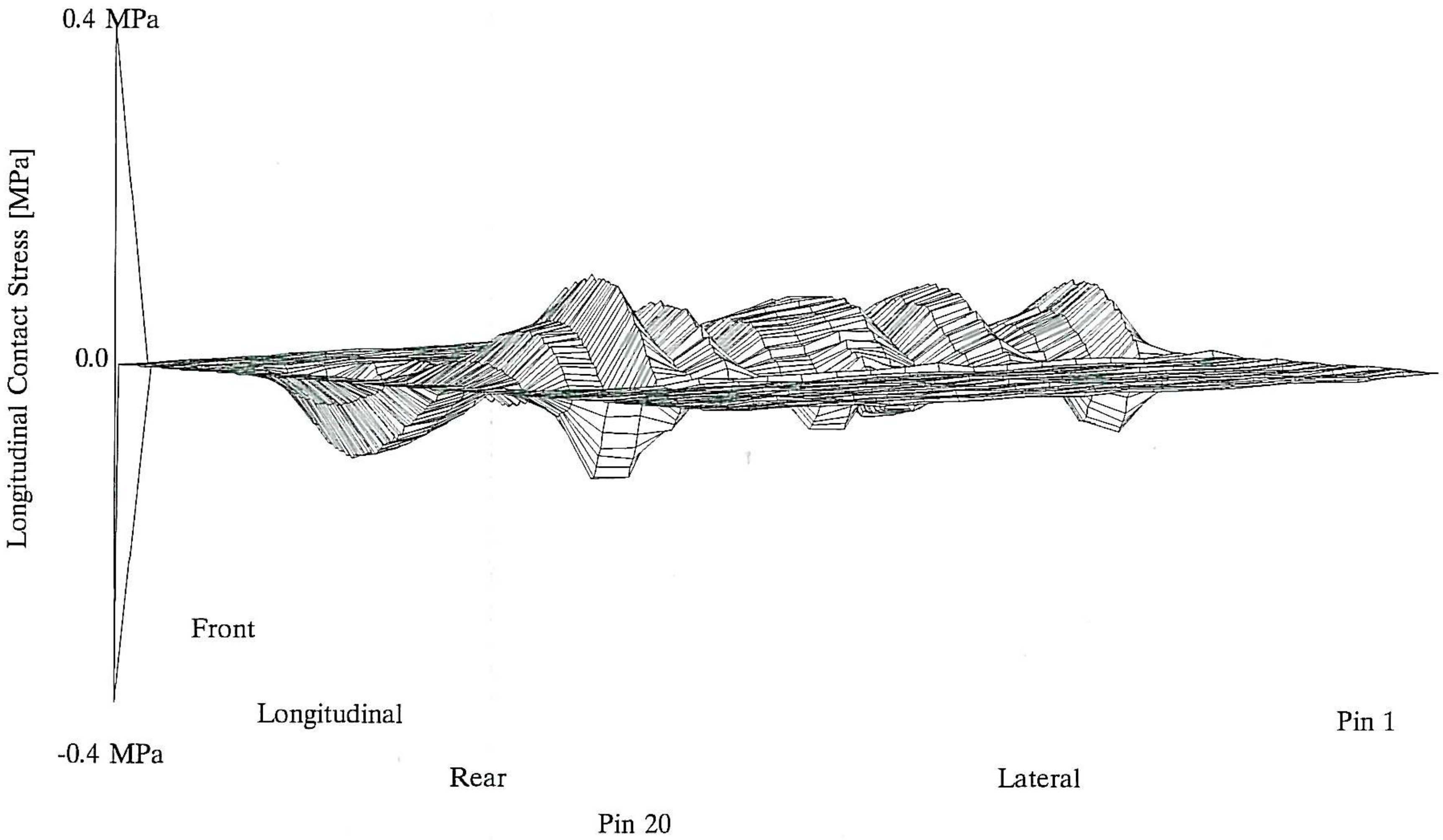
Filename : nnsc75ay

New Bridgestone 425/65R22.5 R164BZ

FIGURE E5Y

Applied Vertical Load (HVS) = 50 kN
Measured Longitudinal Load = 0.1887 kN
Max. Stress = 0.1246 MPa
Min. Stress = -0.1088 MPa

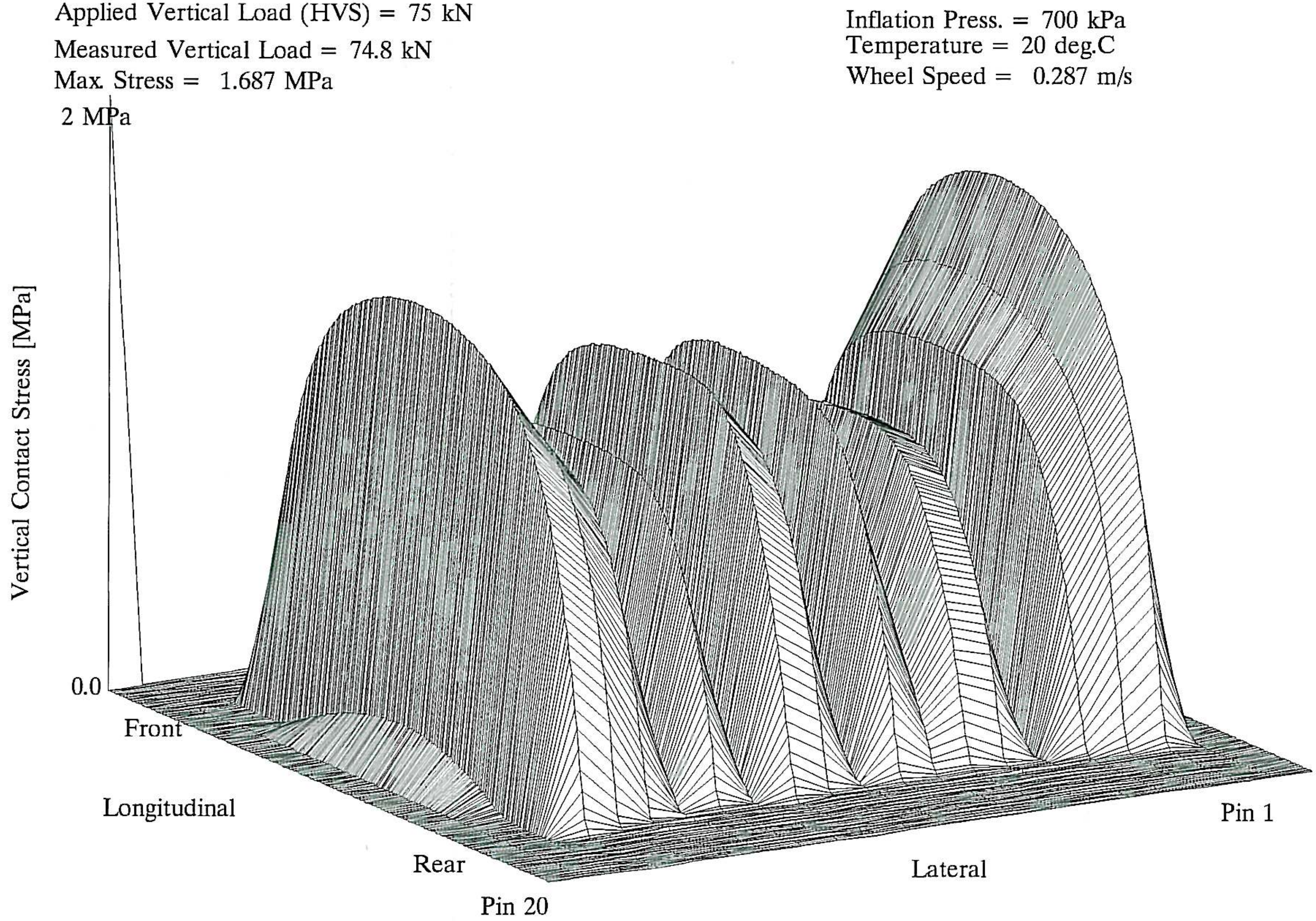
Inflation Press. = 700 kPa
Temperature = 20 deg.C
Wheel Speed = 0.296 m/s



New Bridgestone 425/65R22.5 R164BZ

Filename : nnsc75ax

FIGURE E5X



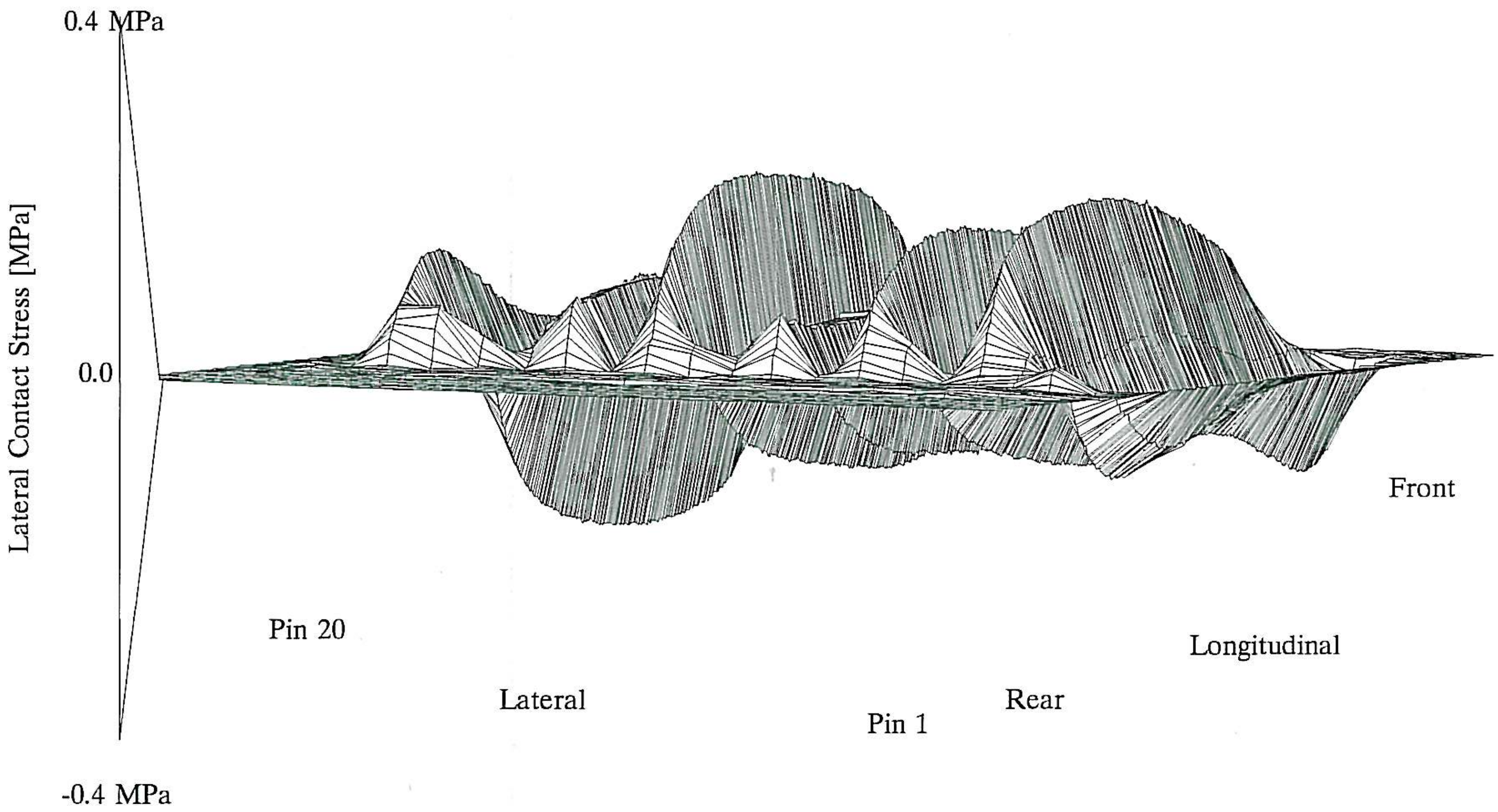
New Bridgestone 425/65R22.5 R164BZ

Filename : nnsc77az

FIGURE E6Z

Applied Vertical Load (HVS) = 75 kN
Measured Lateral Load = 1.174 kN
Max. Stress = 0.212 MPa
Min. Stress = -0.193 MPa

Inflation Press. = 700 kPa
Temperature = 20 deg.C
Wheel Speed = 0.287 m/s



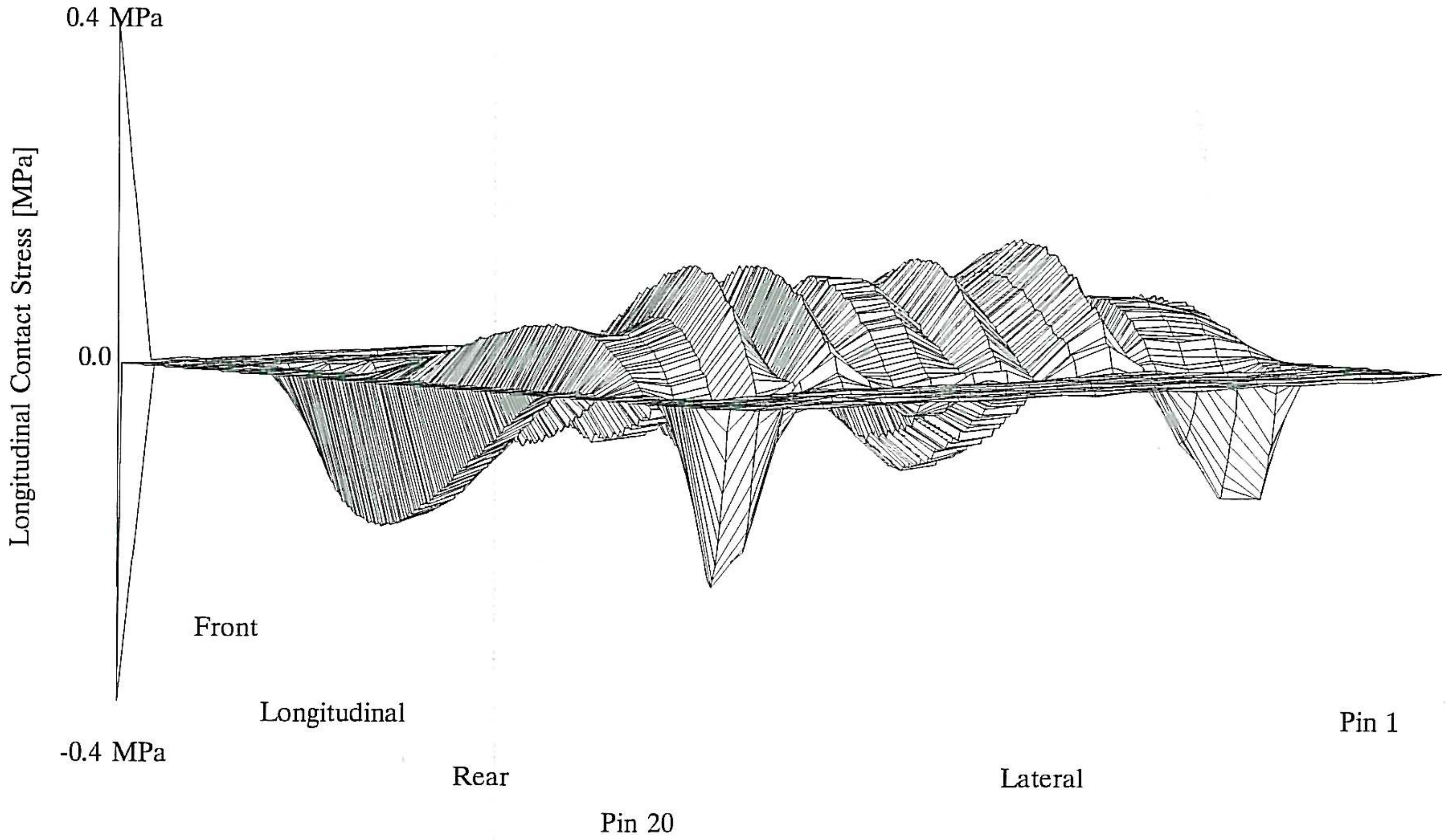
Filename : nnsc77ay

New Bridgestone 425/65R22.5 R164BZ

FIGURE E6Y

Applied Vertical Load (HVS) = 75 kN
Measured Longitudinal Load = -0.08183 kN
Max. Stress = 0.1531 MPa
Min. Stress = -0.2283 MPa

Inflation Press. = 700 kPa
Temperature = 20 deg.C
Wheel Speed = 0.287 m/s



New Bridgestone 425/65R22.5 R164BZ

Filename : nnsc77ax

FIGURE E6X

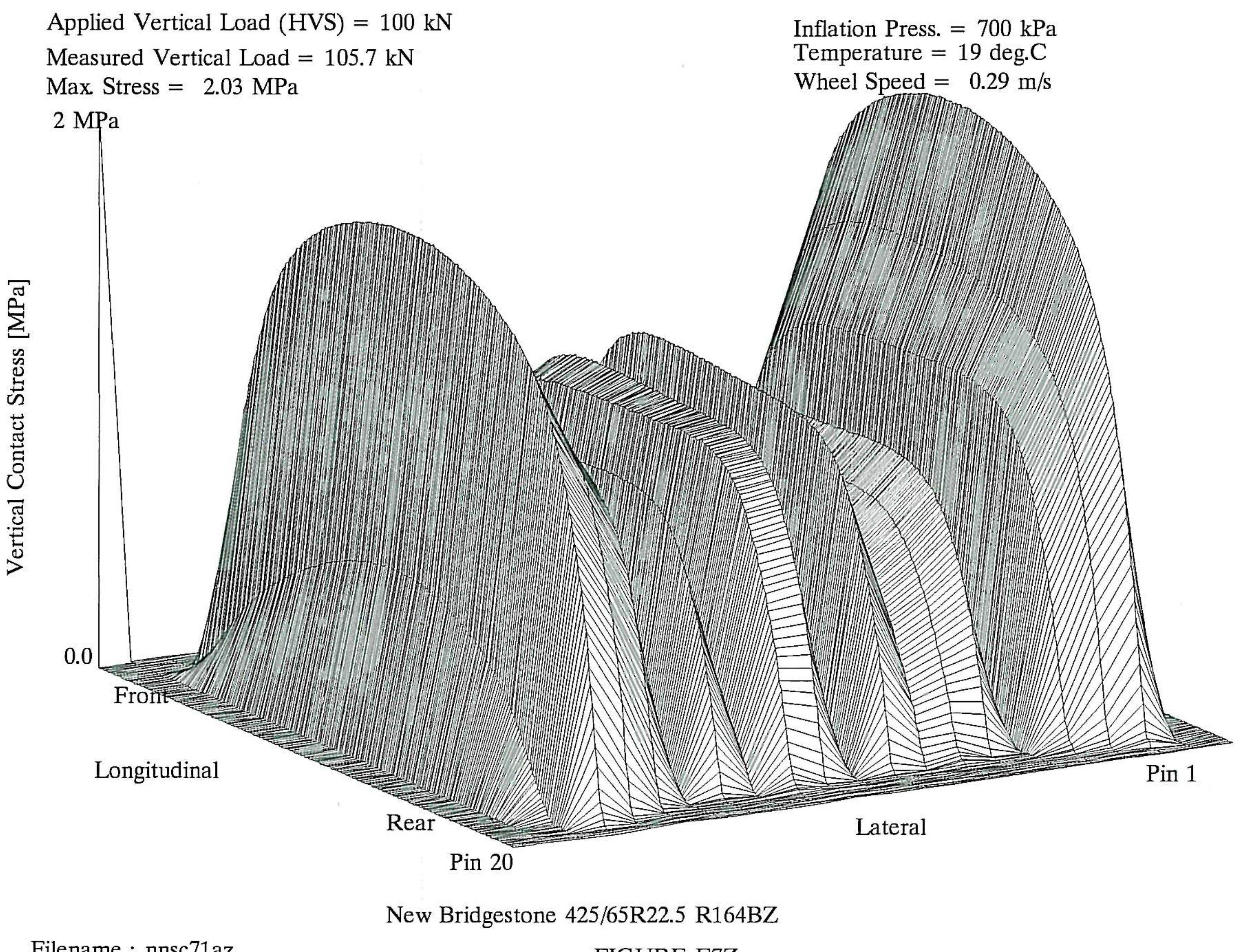
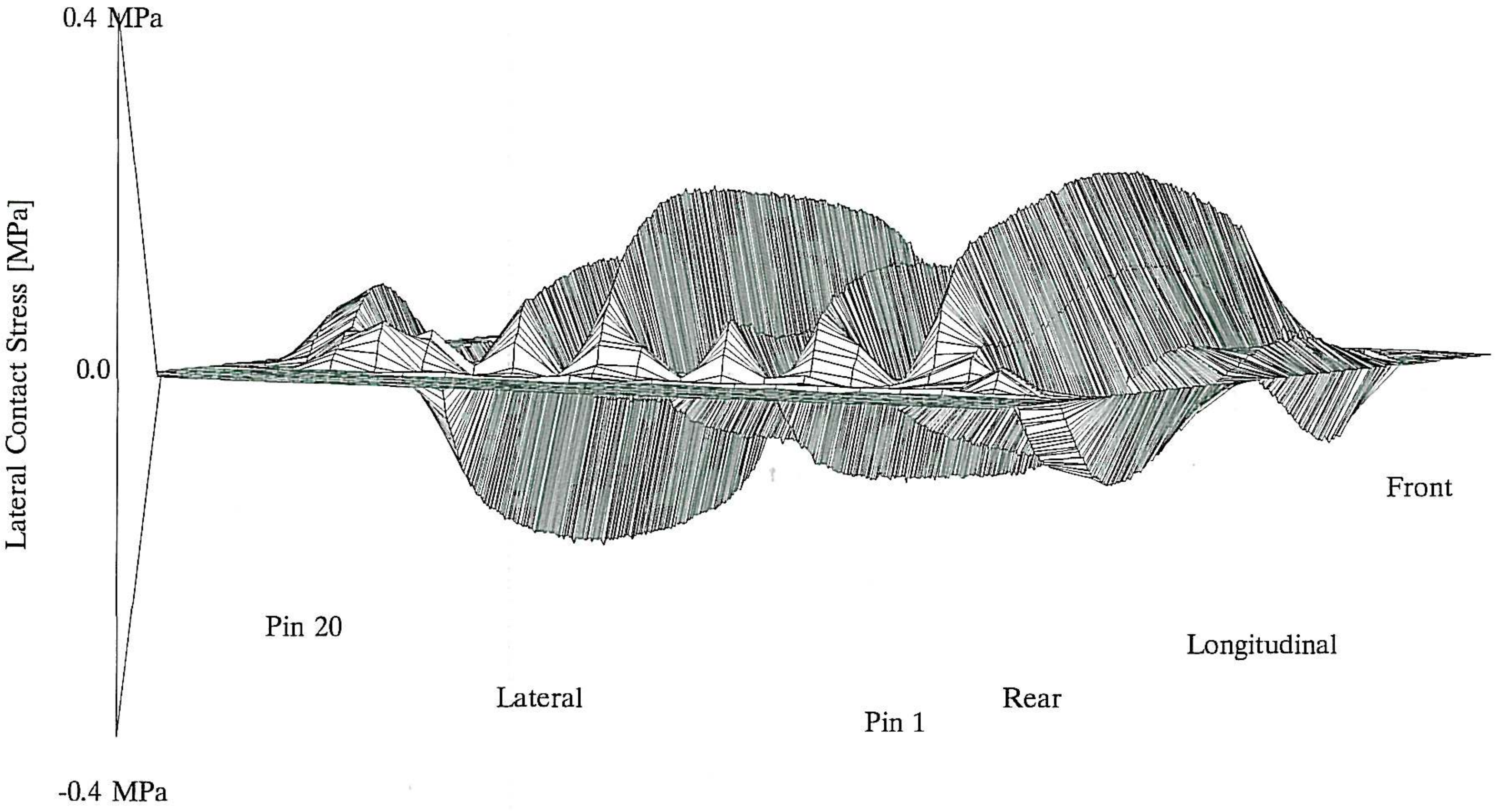

Applied Vertical Load (HVS) = 100 kN
Measured Vertical Load = 105.7 kN
Max. Stress = 2.03 MPa
Inflation Press. = 700 kPa
Temperature = 19 deg.C
Wheel Speed = 0.29 m/s
2 MPa
Vertical Contact Stress [MPa]
0.0
Front
Longitudinal
Rear
Pin 20
Lateral
Pin 1
New Bridgestone 425/65R22.5 R164BZ
Filename : nnsc71az

FIGURE E7Z

Applied Vertical Load (HVS) = 100 kN
Measured Lateral Load = 0.5642 kN
Max. Stress = 0.2212 MPa
Min. Stress = -0.212 MPa

Inflation Press. = 700 kPa
Temperature = 19 deg.C
Wheel Speed = 0.29 m/s



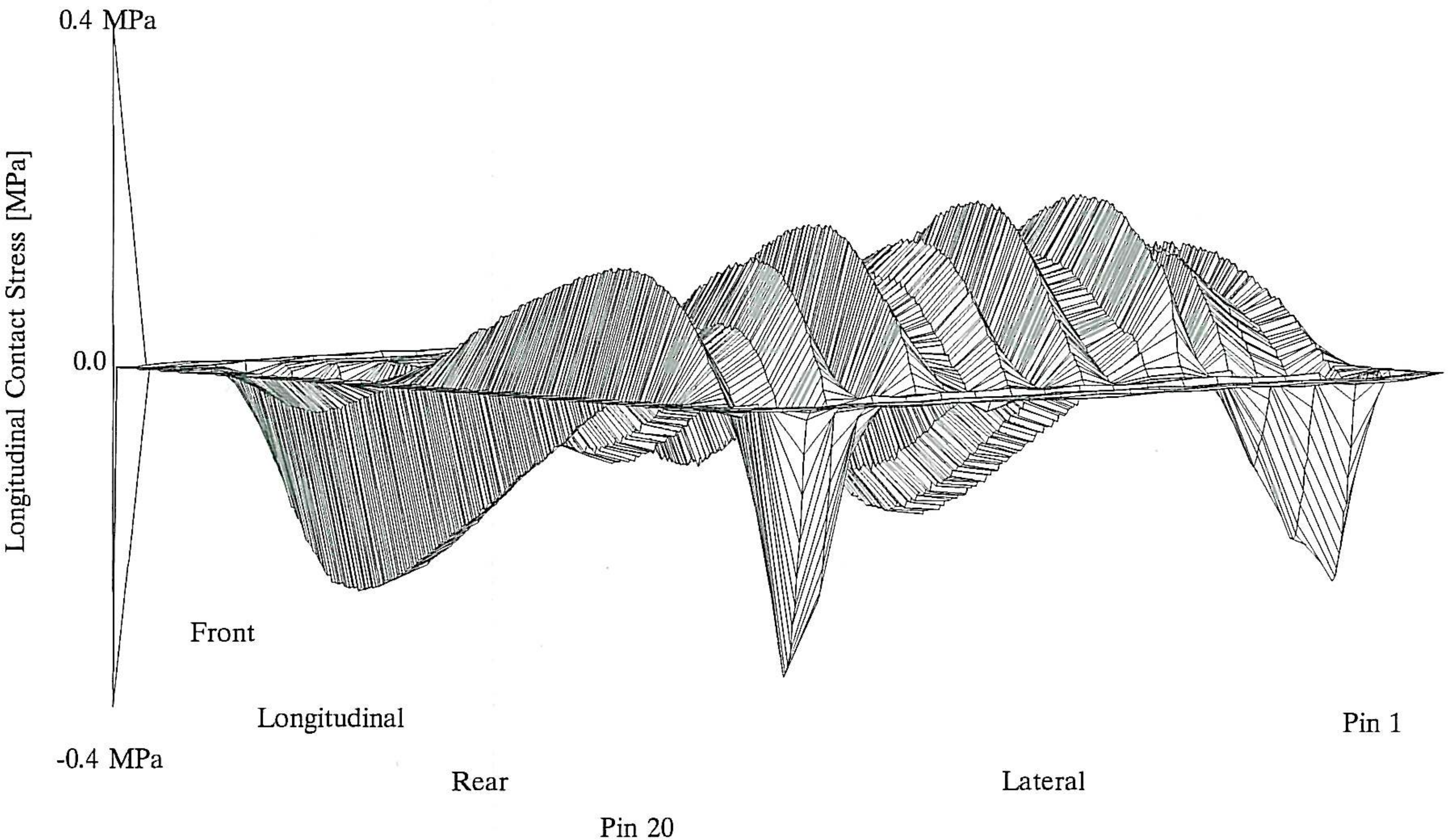
Filename : nnsc71ay

New Bridgestone 425/65R22.5 R164BZ

FIGURE E7Y

Applied Vertical Load (HVS) = 100 kN
Measured Longitudinal Load = -0.1164 kN
Max. Stress = 0.2102 MPa
Min. Stress = -0.3229 MPa

Inflation Press. = 700 kPa
Temperature = 19 deg.C
Wheel Speed = 0.29 m/s



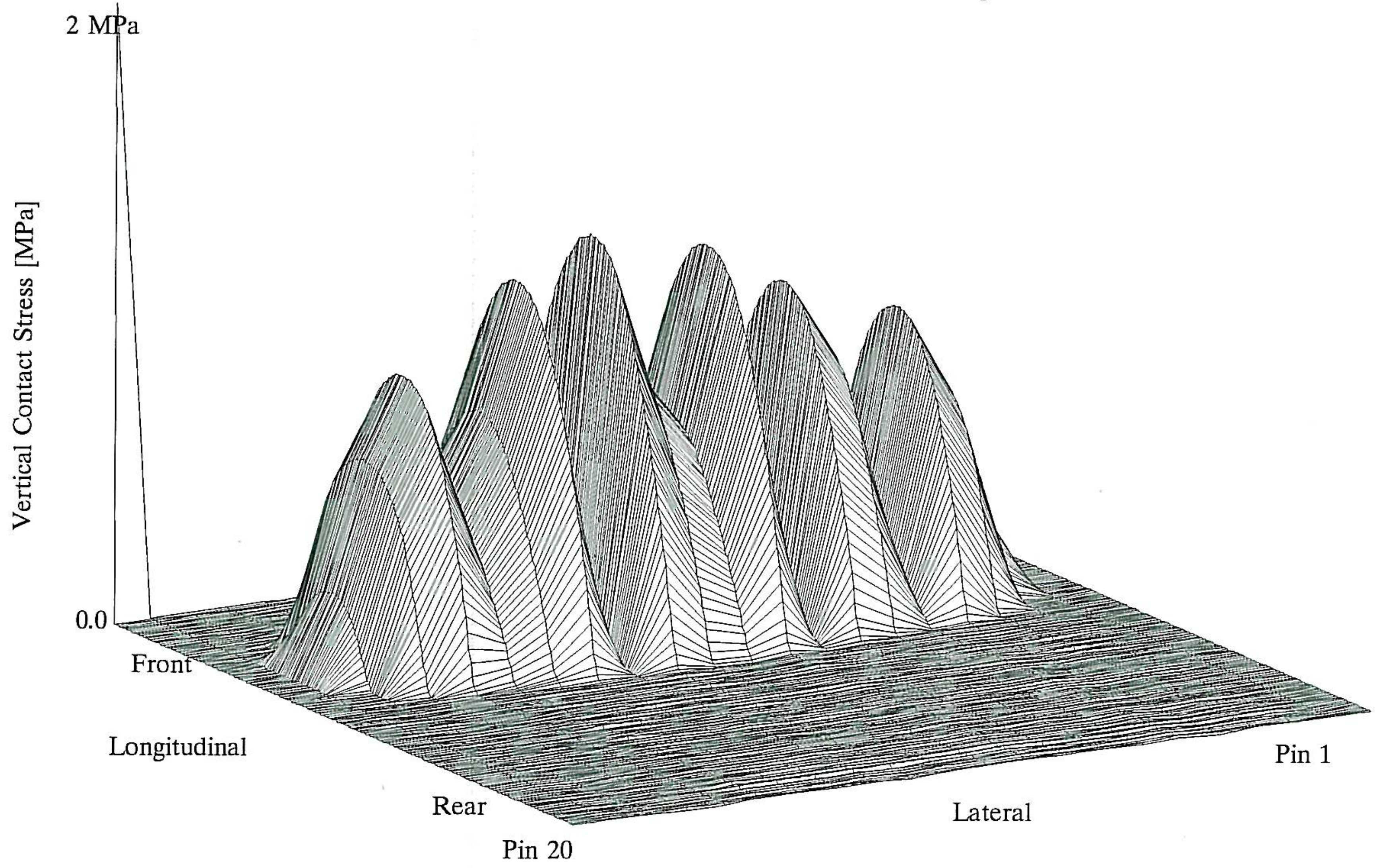
New Bridgestone 425/65R22.5 R164BZ

Filename : nnsc71ax

FIGURE E7X

Applied Vertical Load (HVS) = 25 kN
Measured Vertical Load = 23.69 kN
Max. Stress = 1.293 MPa

Inflation Press. = 900 kPa
Temperature = 15 deg.C
Wheel Speed = 0.297 m/s



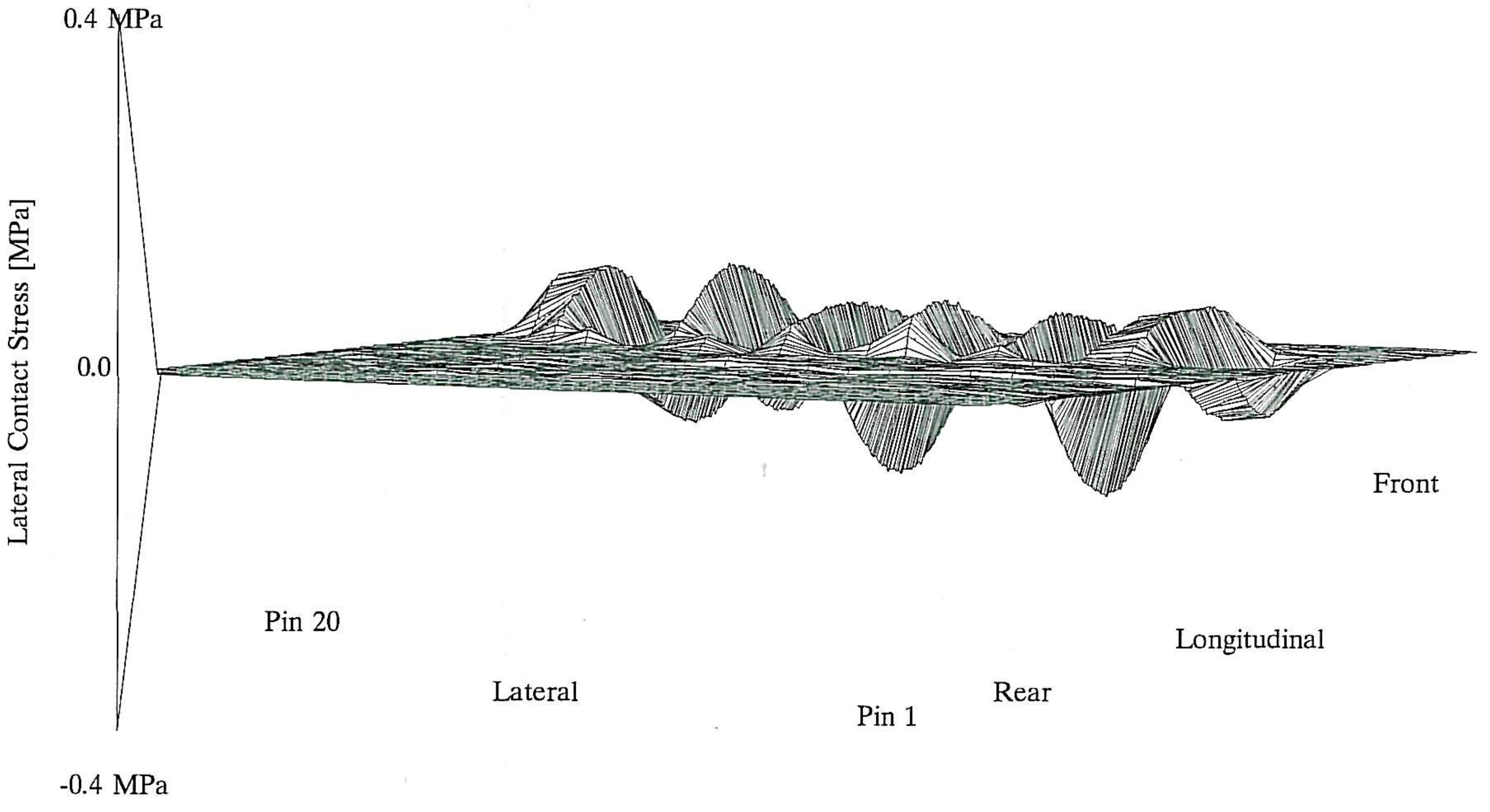
New Bridgestone 425/65R22.5 R164BZ

Filename : nnc902az

FIGURE E8Z

Applied Vertical Load (HVS) = 25 kN
Measured Lateral Load = -0.3657 kN
Max. Stress = 0.0899 MPa
Min. Stress = -0.1571 MPa

Inflation Press. = 900 kPa
Temperature = 15 deg.C
Wheel Speed = 0.297 m/s



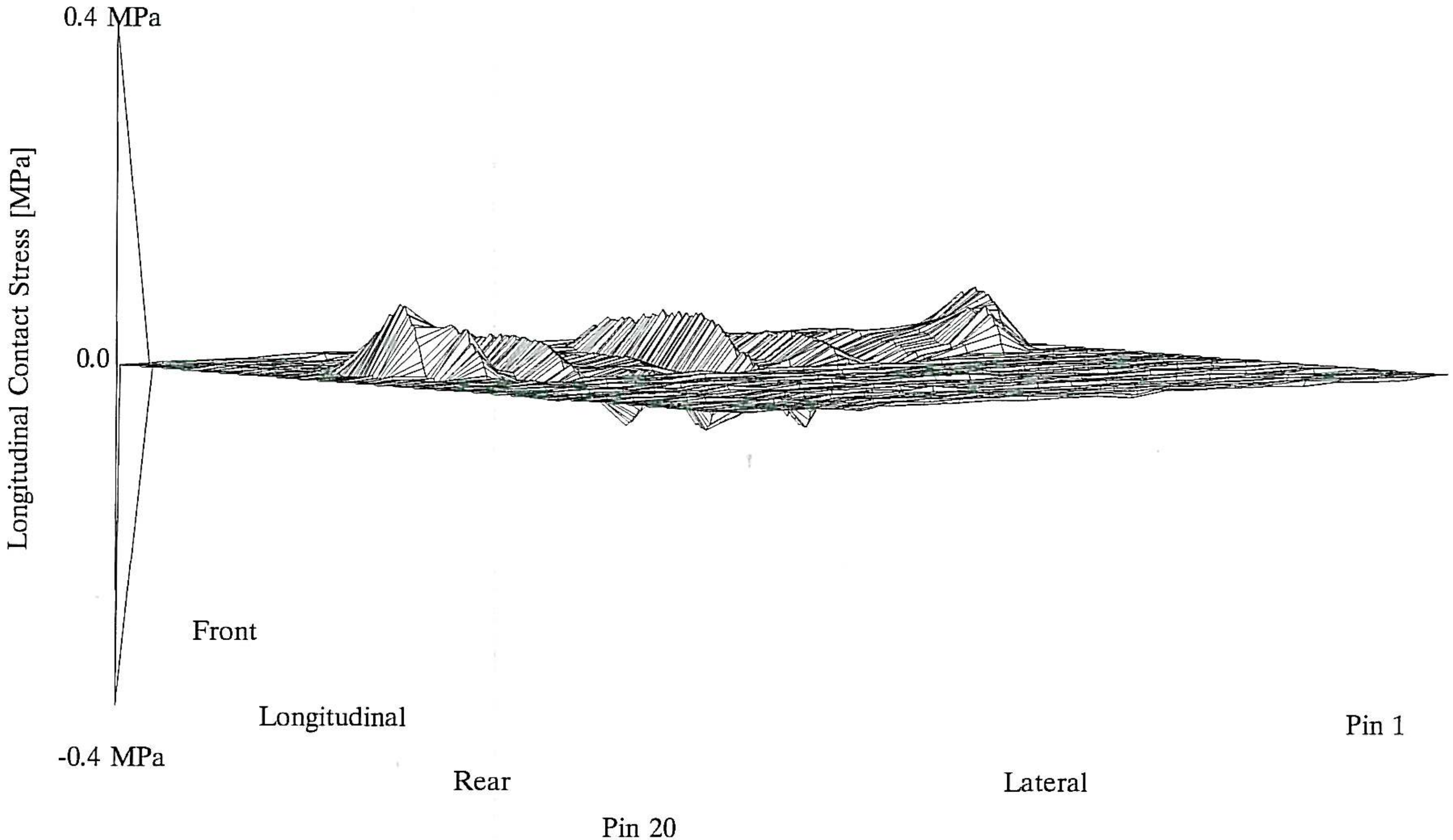
Filename : nnc902ay

New Bridgestone 425/65R22.5 R164BZ

FIGURE E8Y

Applied Vertical Load (HVS) = 25 kN
Measured Longitudinal Load = 0.1418 kN
Max. Stress = 0.08674 MPa
Min. Stress = -0.07308 MPa

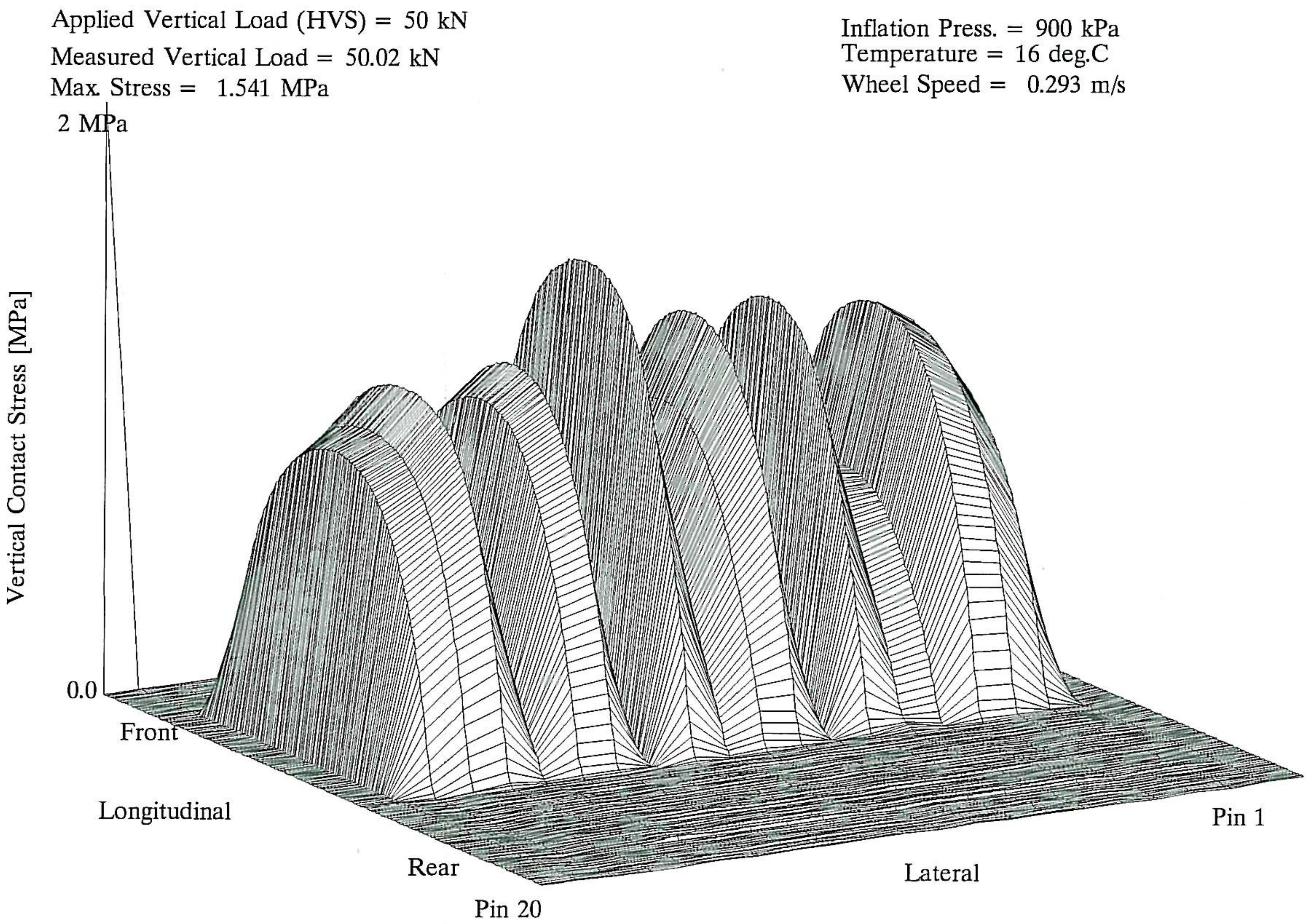
Inflation Press. = 900 kPa
Temperature = 15 deg.C
Wheel Speed = 0.297 m/s



New Bridgestone 425/65R22.5 R164BZ

FIGURE E8X

Filename : nnc902ax



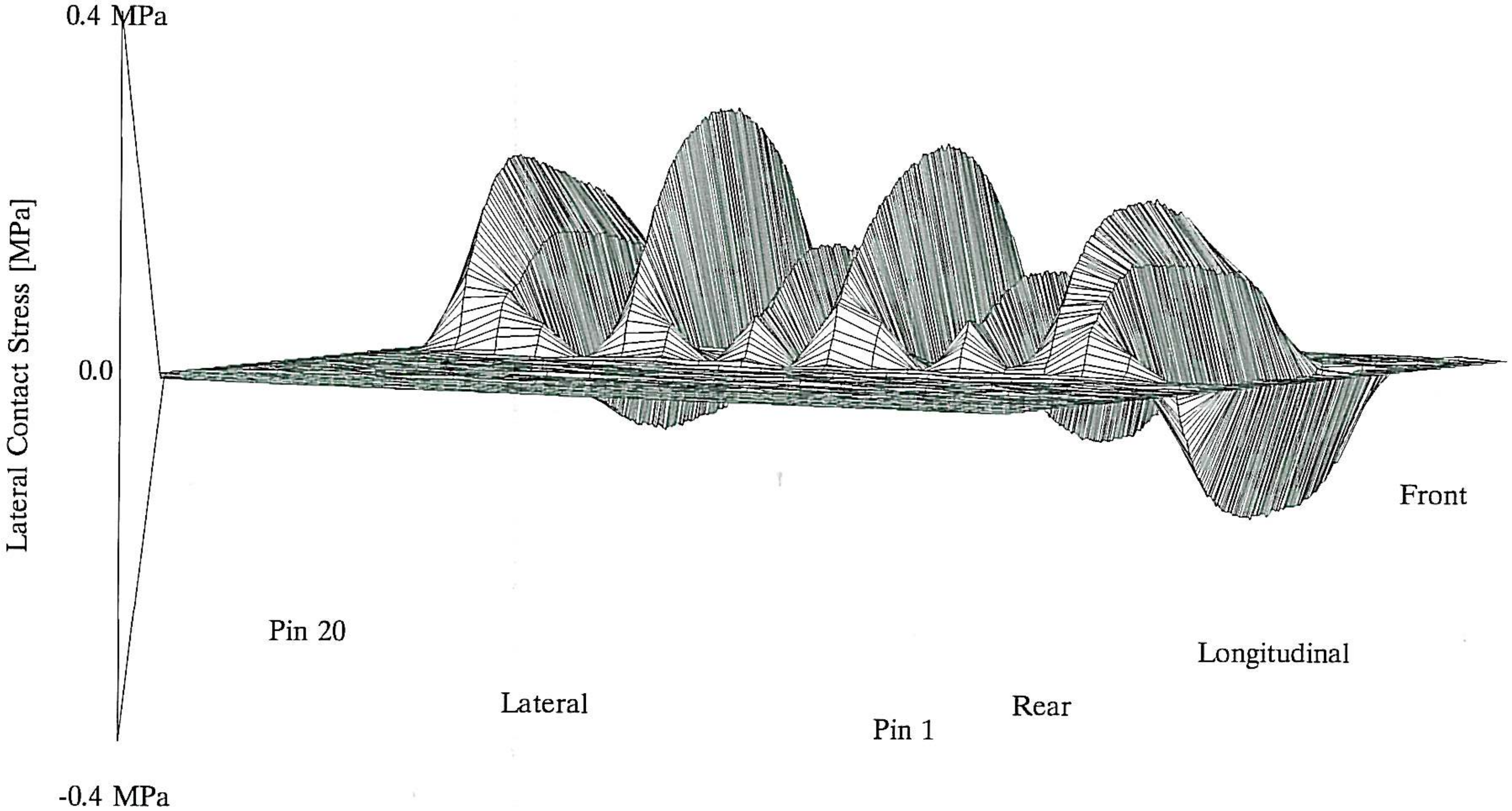
New Bridgestone 425/65R22.5 R164BZ

Filename : nnc905az

FIGURE E9Z

Applied Vertical Load (HVS) = 50 kN
Measured Lateral Load = 2.562 kN
Max. Stress = 0.2655 MPa
Min. Stress = -0.1595 MPa

Inflation Press. = 900 kPa
Temperature = 16 deg.C
Wheel Speed = 0.293 m/s



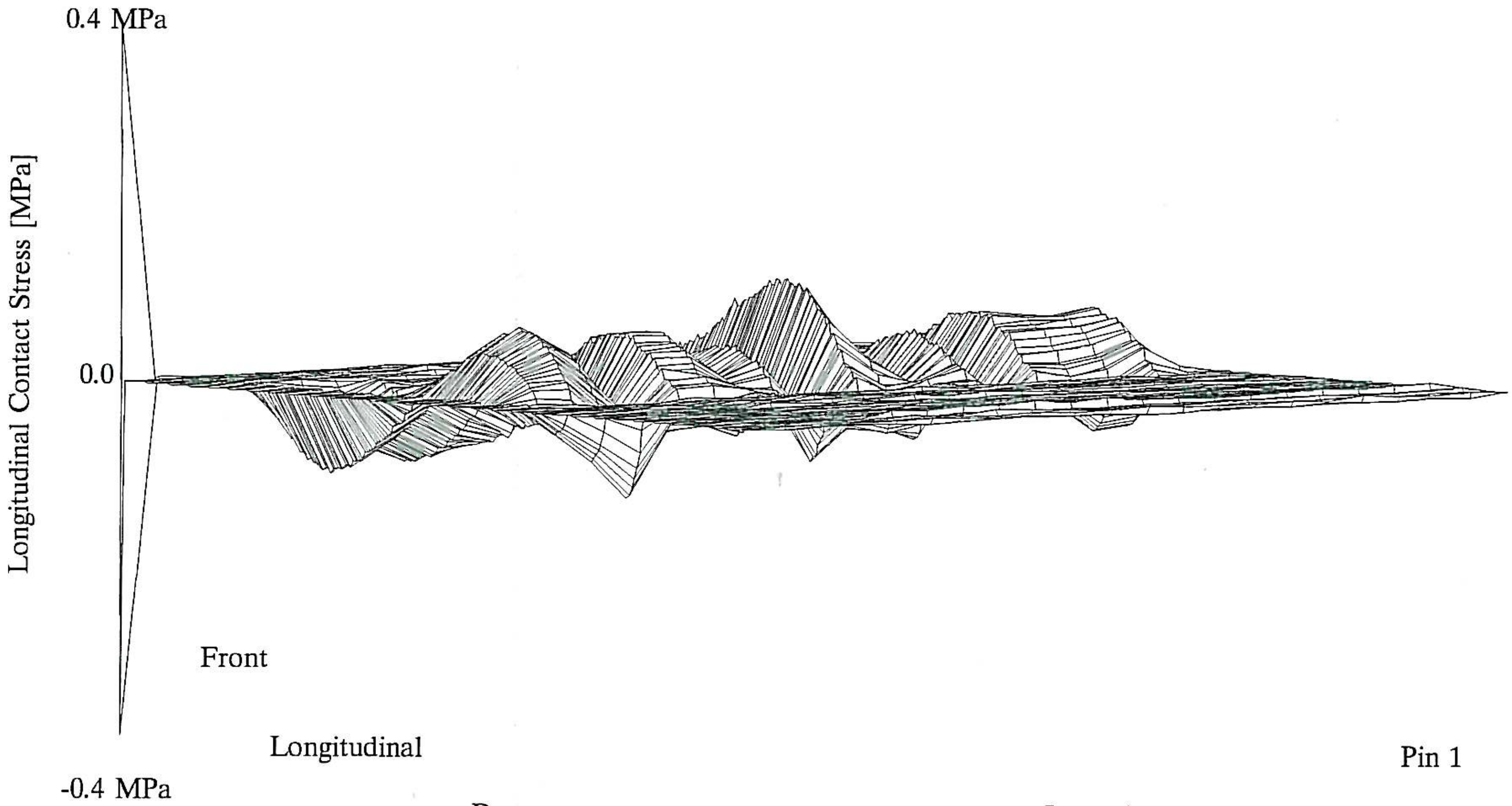
Filename : nnc905ay

New Bridgestone 425/65R22.5 R164BZ

FIGURE E9Y

Applied Vertical Load (HVS) = 50 kN
Measured Longitudinal Load = -0.134 kN
Max. Stress = 0.1169 MPa
Min. Stress = -0.1098 MPa

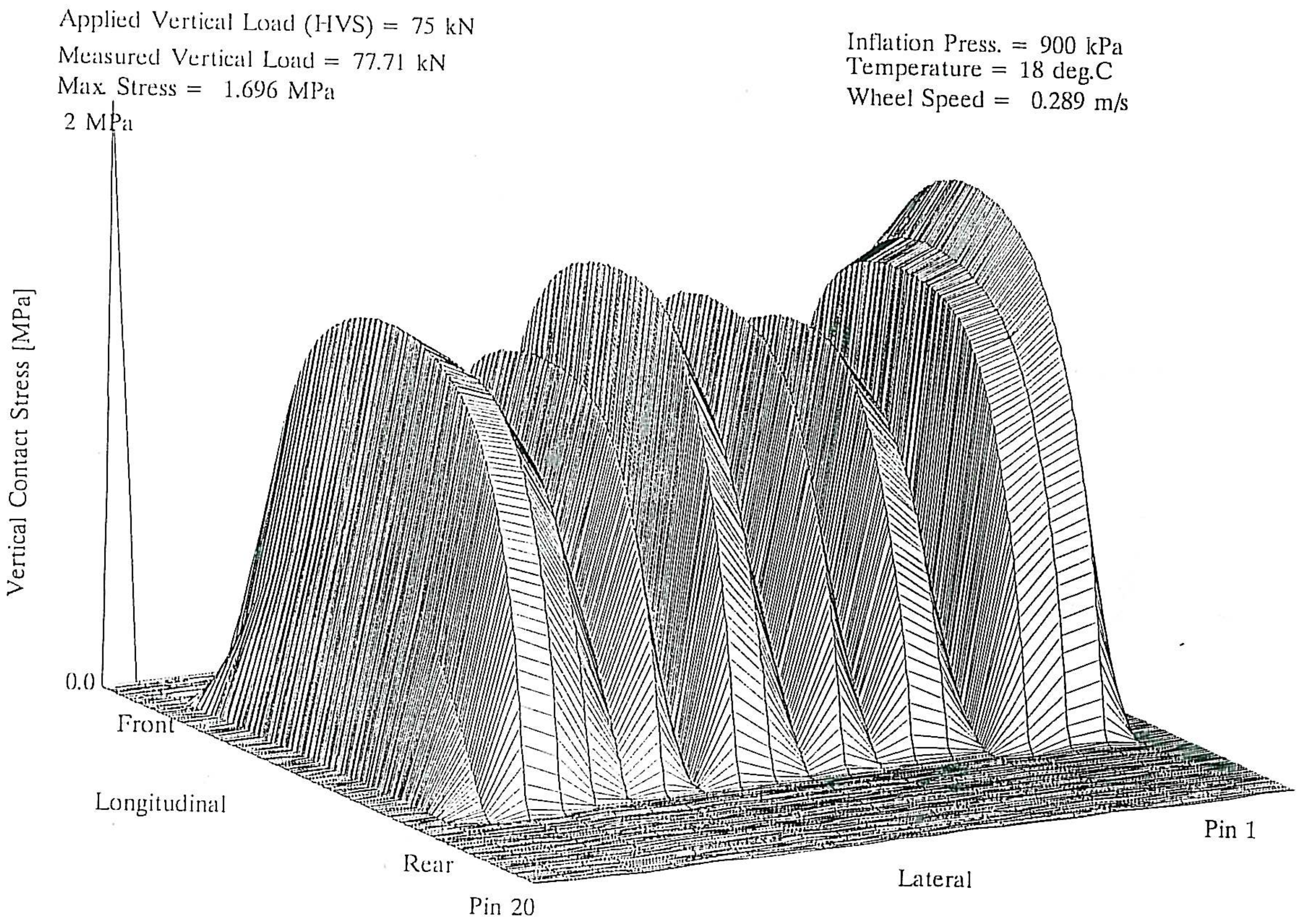
Inflation Press. = 900 kPa
Temperature = 16 deg.C
Wheel Speed = 0.293 m/s



New Bridgestone 425/65R22.5 R164BZ

Filename : nnc905ax

FIGURE E9X



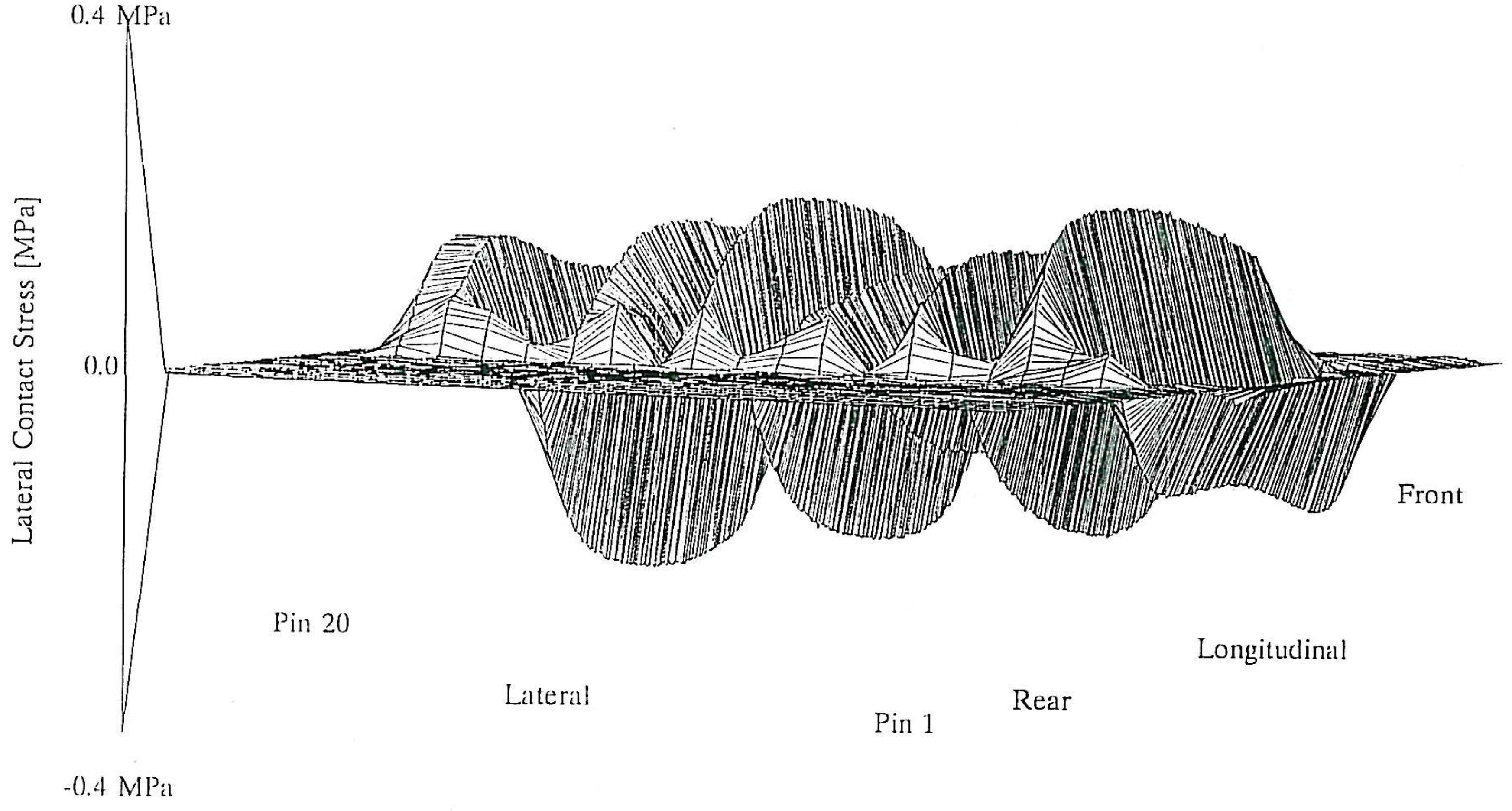
New Bridgestone 425/65R22.5 R164BZ

FIGURE E10Z

Filename : nnc907az

Applied Vertical Load (HVS) = 75 kN
Measured Lateral Load = 0.3353 kN
Max. Stress = 0.189 MPa
Min. Stress = -0.2424 MPa

Inflation Press. = 900 kPa
Temperature = 18 deg.C
Wheel Speed = 0.289 m/s



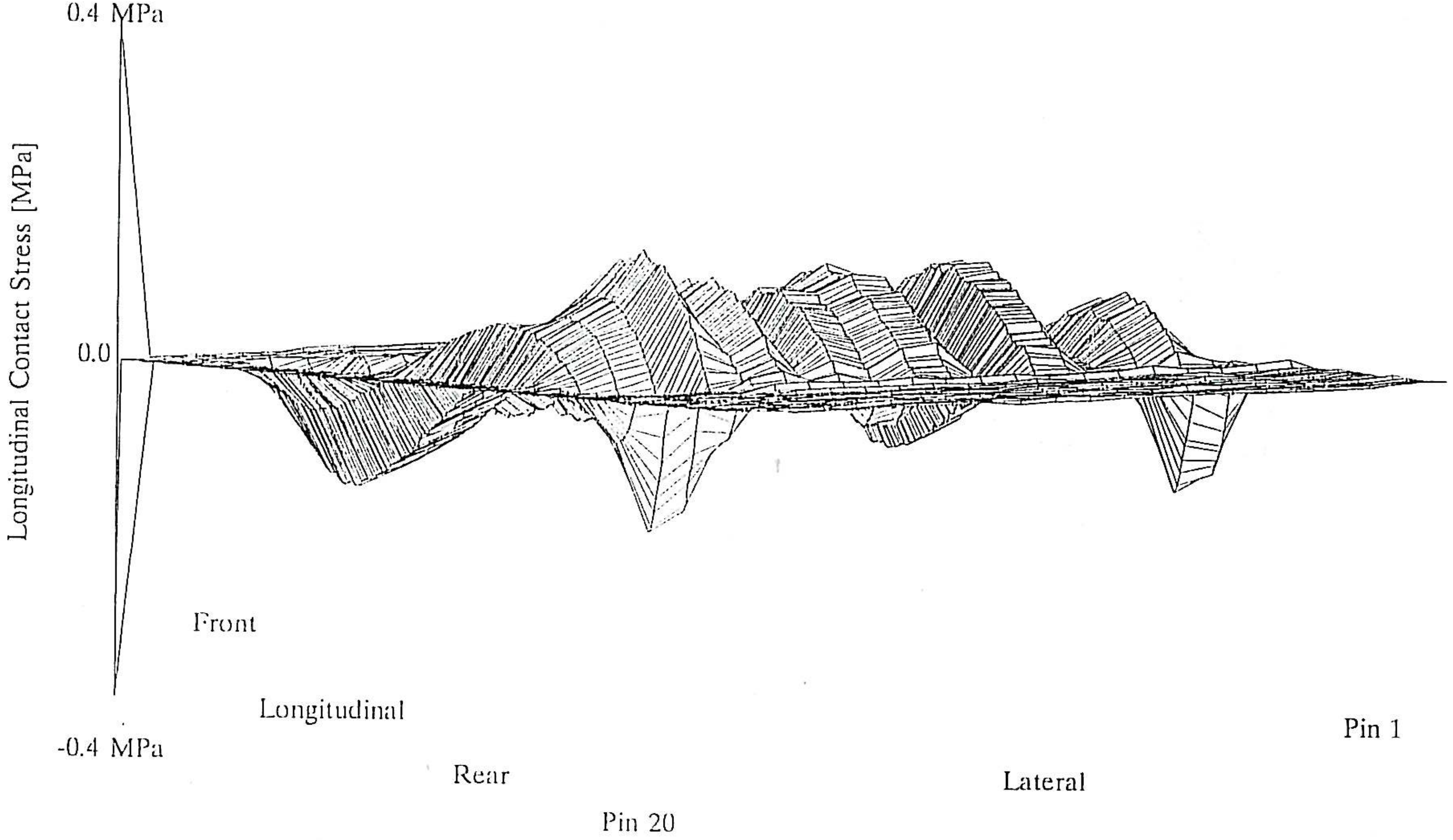
Filename : nnc907ay

New Bridgestone 425/65R22.5 R164BZ

FIGURE E10Y

Applied Vertical Load (HVS) = 75 kN
Measured Longitudinal Load = 0.4927 kN
Max. Stress = 0.1569 MPa
Min. Stress = -0.1693 MPa

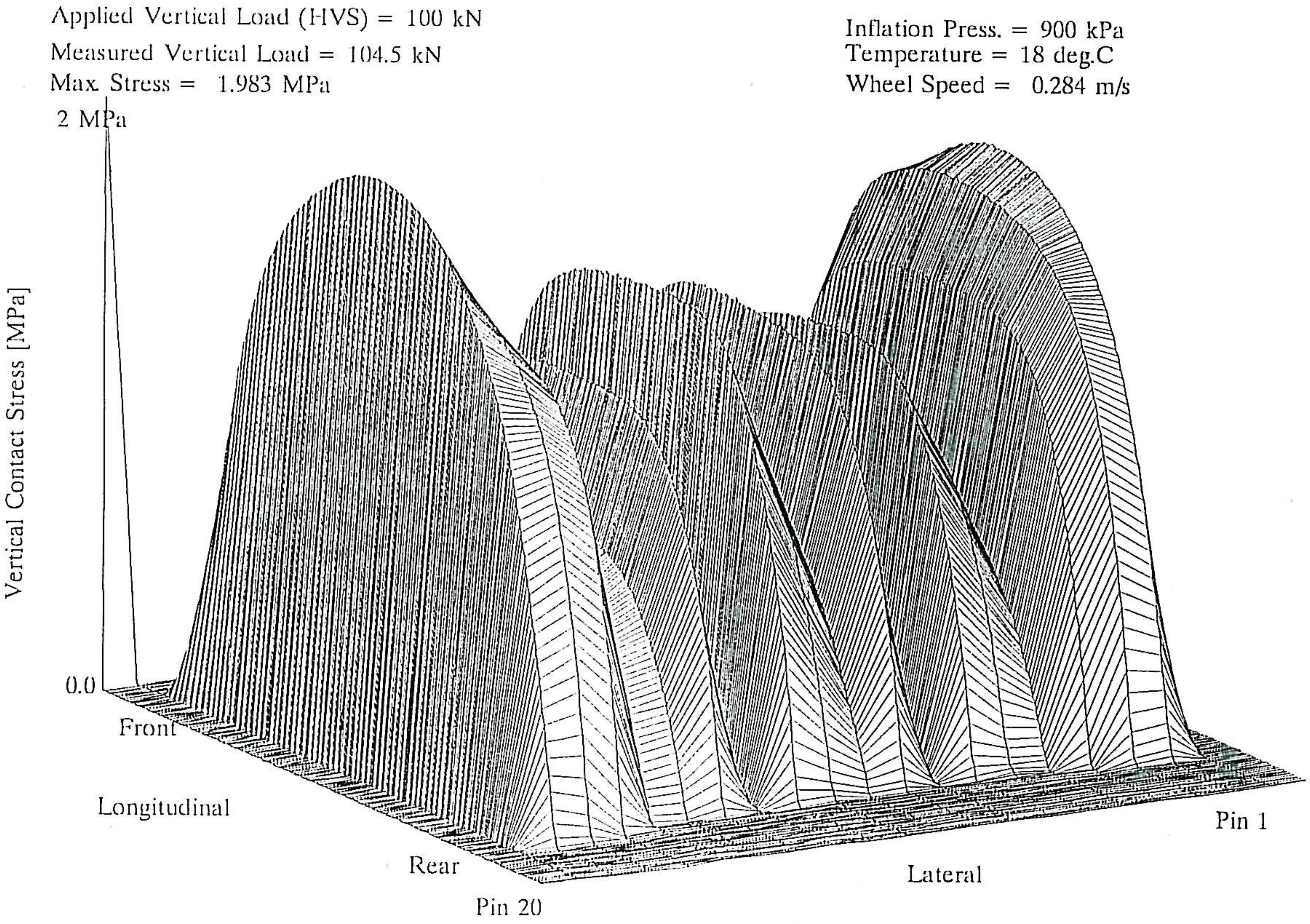
Inflation Press. = 900 kPa
Temperature = 18 deg.C
Wheel Speed = 0.289 m/s



New Bridgestone 425/65R22.5 R164BZ

Filename : nnc907ax

FIGURE E10X



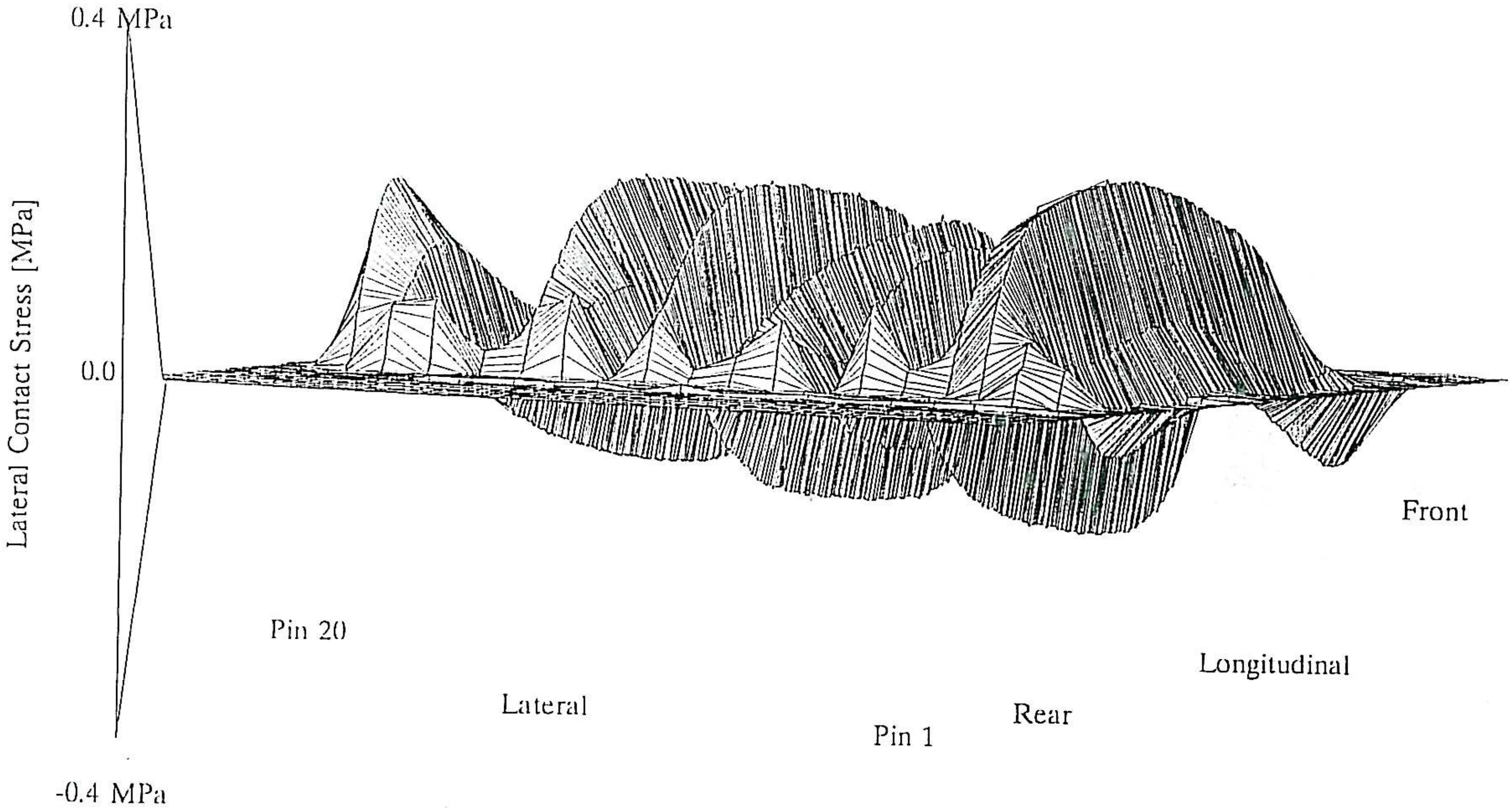
New Bridgestone 425/65R22.5 R164BZ

Filename : nnc901az

FIGURE E11Z

Applied Vertical Load (HVS) = 100 kN
Measured Lateral Load = 4.233 kN
Max. Stress = 0.2335 MPa
Min. Stress = -0.1718 MPa

Inflation Press. = 900 kPa
Temperature = 18 deg.C
Wheel Speed = 0.284 m/s



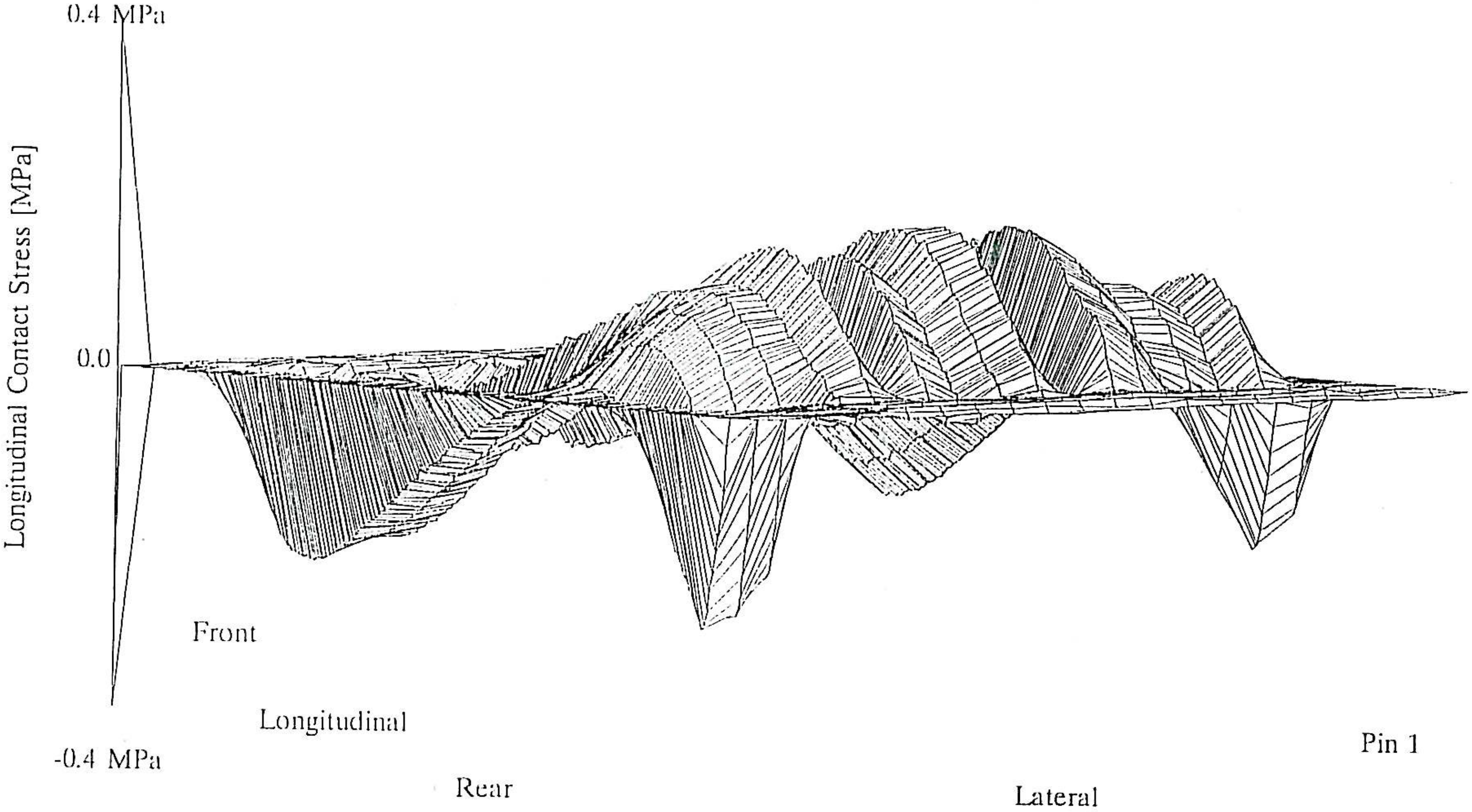
Filename : nnc901ay

New Bridgestone 425/65R22.5 R164BZ

FIGURE E11Y

Applied Vertical Load (HVS) = 100 kN
Measured Longitudinal Load = -0.004589 kN
Max. Stress = 0.1847 MPa
Min. Stress = -0.262 MPa

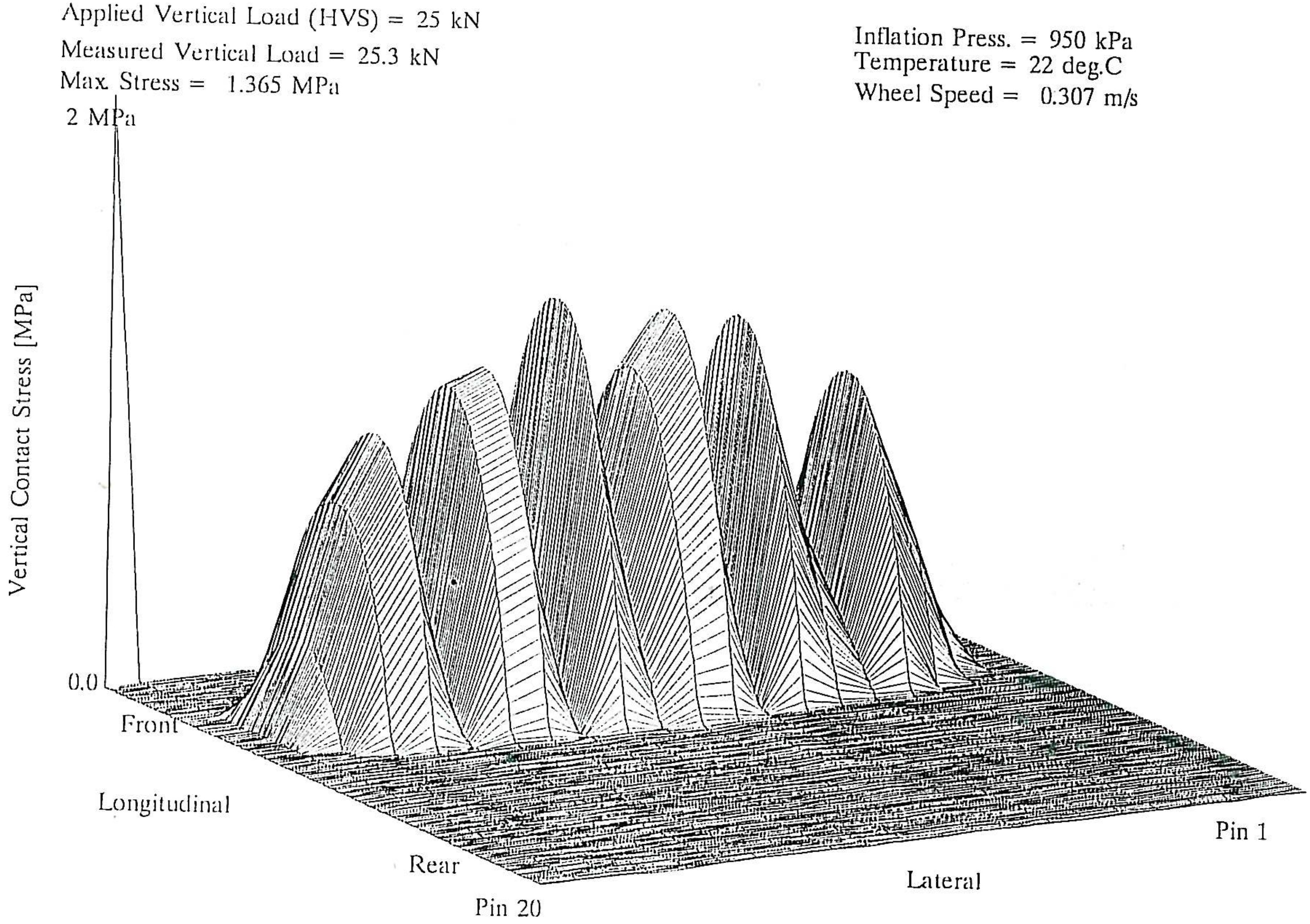
Inflation Press. = 900 kPa
Temperature = 18 deg.C
Wheel Speed = 0.284 m/s



New Bridgestone 425/65R22.5 R164BZ

FIGURE E11X

Filename : nnc901ax



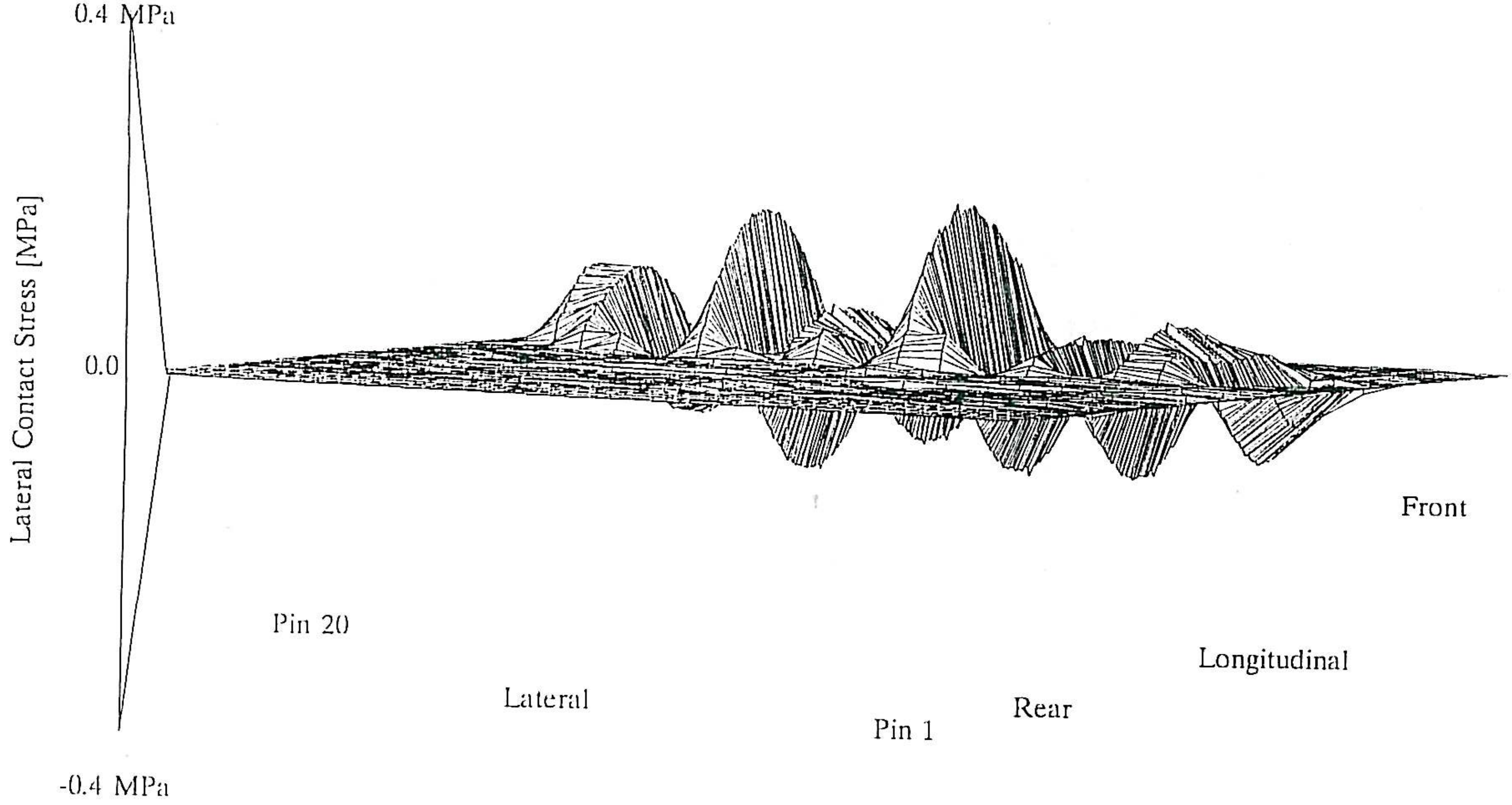
New Bridgestone 425/65R22.5 R164BZ

Filename : nnsc92az

FIGURE E12Z

Applied Vertical Load (HVS) = 25 kN
Measured Lateral Load = -0.0141 kN
Max. Stress = 0.1784 MPa
Min. Stress = -0.1285 MPa

Inflation Press. = 950 kPa
Temperature = 22 deg.C
Wheel Speed = 0.307 m/s



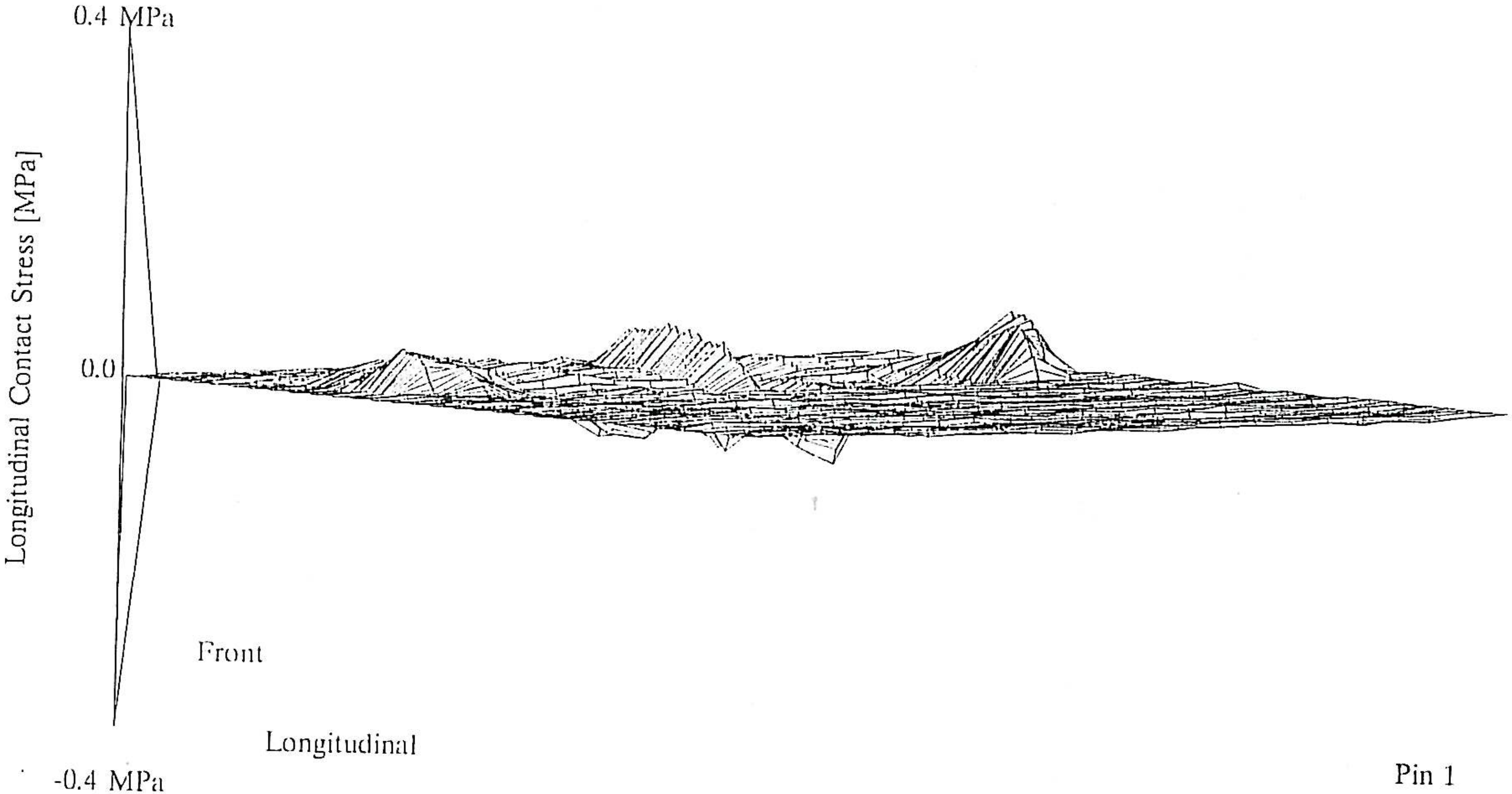
Filename : nnsc92ay

New Bridgestone 425/65R22.5 R164BZ

FIGURE E12Y

Applied Vertical Load (HVS) = 25 kN
Measured Longitudinal Load = 0.04043 kN
Max. Stress = 0.0746 MPa
Min. Stress = -0.08411 MPa

Inflation Press. = 950 kPa
Temperature = 22 deg.C
Wheel Speed = 0.307 m/s



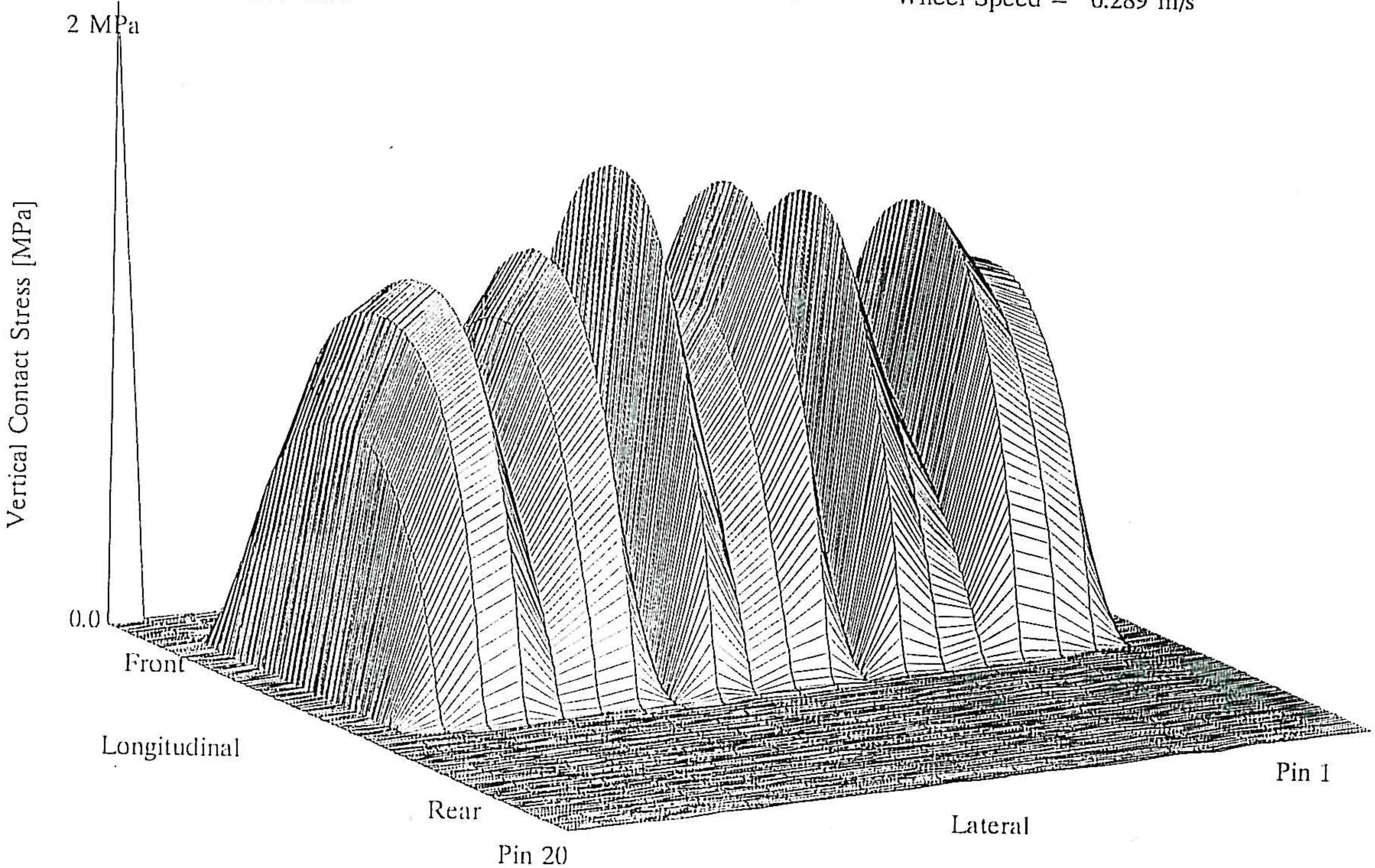
New Bridgestone 425/65R22.5 R164BZ

Filename : nnsc92ax

FIGURE E12X

Applied Vertical Load (HVS) = 50 kN
Measured Vertical Load = 50.54 kN
Max. Stress = 1.559 MPa

Inflation Press. = 950 kPa
Temperature = 21 deg.C
Wheel Speed = 0.289 m/s



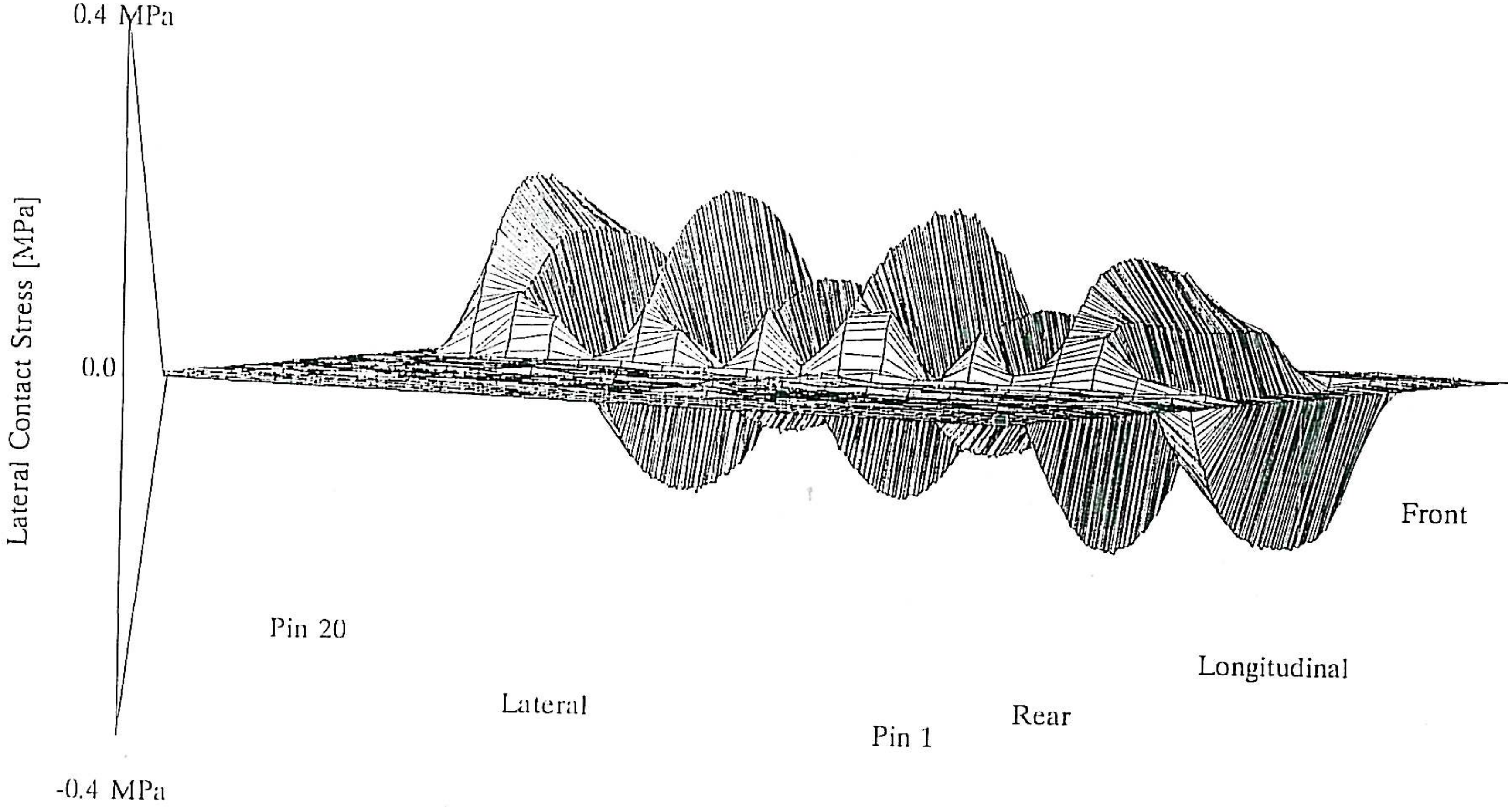
New Bridgestone 425/65R22.5 R164BZ

FIGURE E13Z

Filename : nnsc95az

Applied Vertical Load (HVS) = 50 kN
Measured Lateral Load = 0.4407 kN
Max. Stress = 0.198 MPa
Min. Stress = -0.1934 MPa

Inflation Press. = 950 kPa
Temperature = 21 deg.C
Wheel Speed = 0.289 m/s



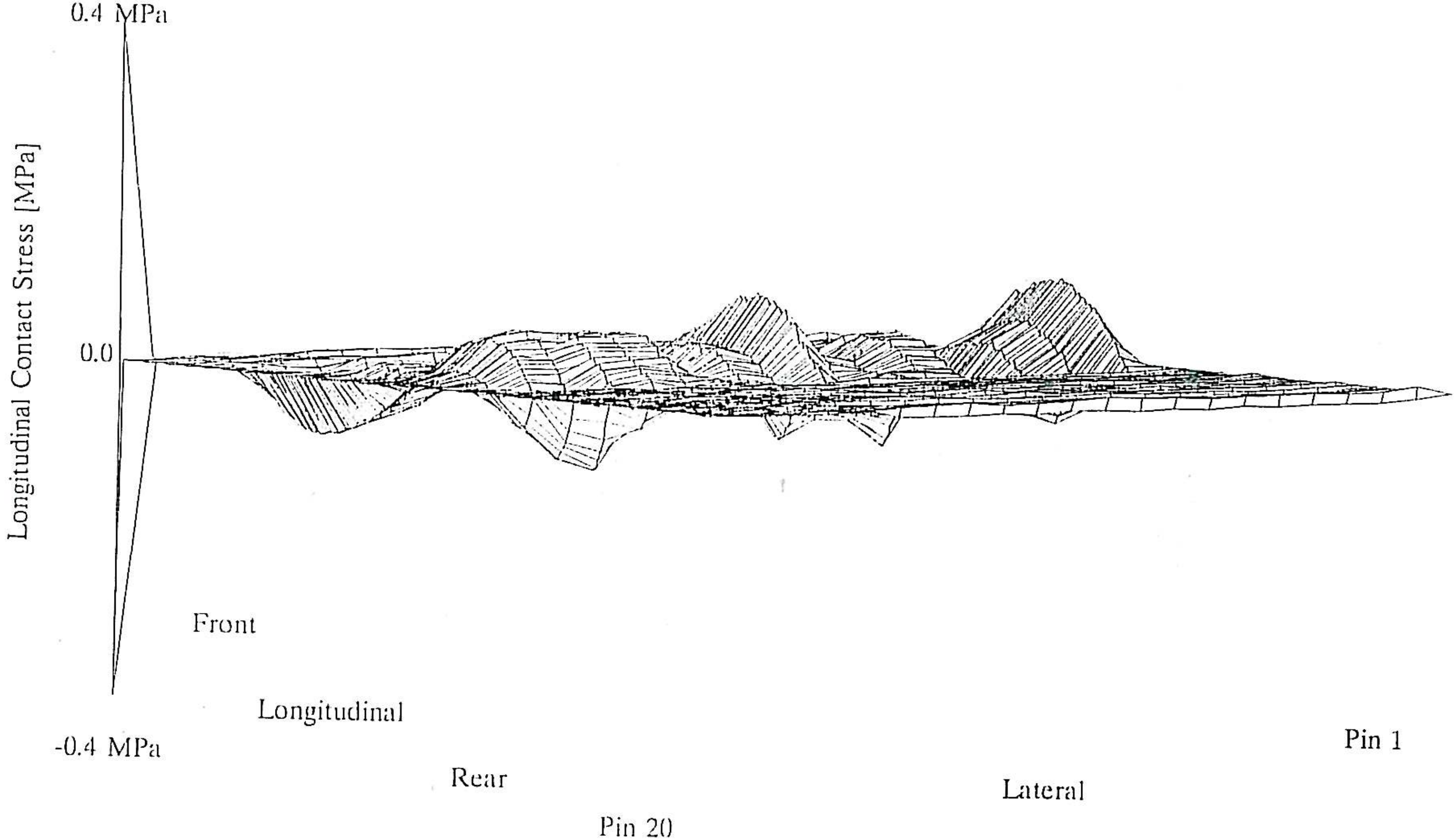
Filename : nnsc95ay

New Bridgestone 425/65R22.5 R164BZ

FIGURE E13Y

Applied Vertical Load (HVS) = 50 kN
Measured Longitudinal Load = -0.237 kN
Max. Stress = 0.1046 MPa
Min. Stress = -0.1 MPa

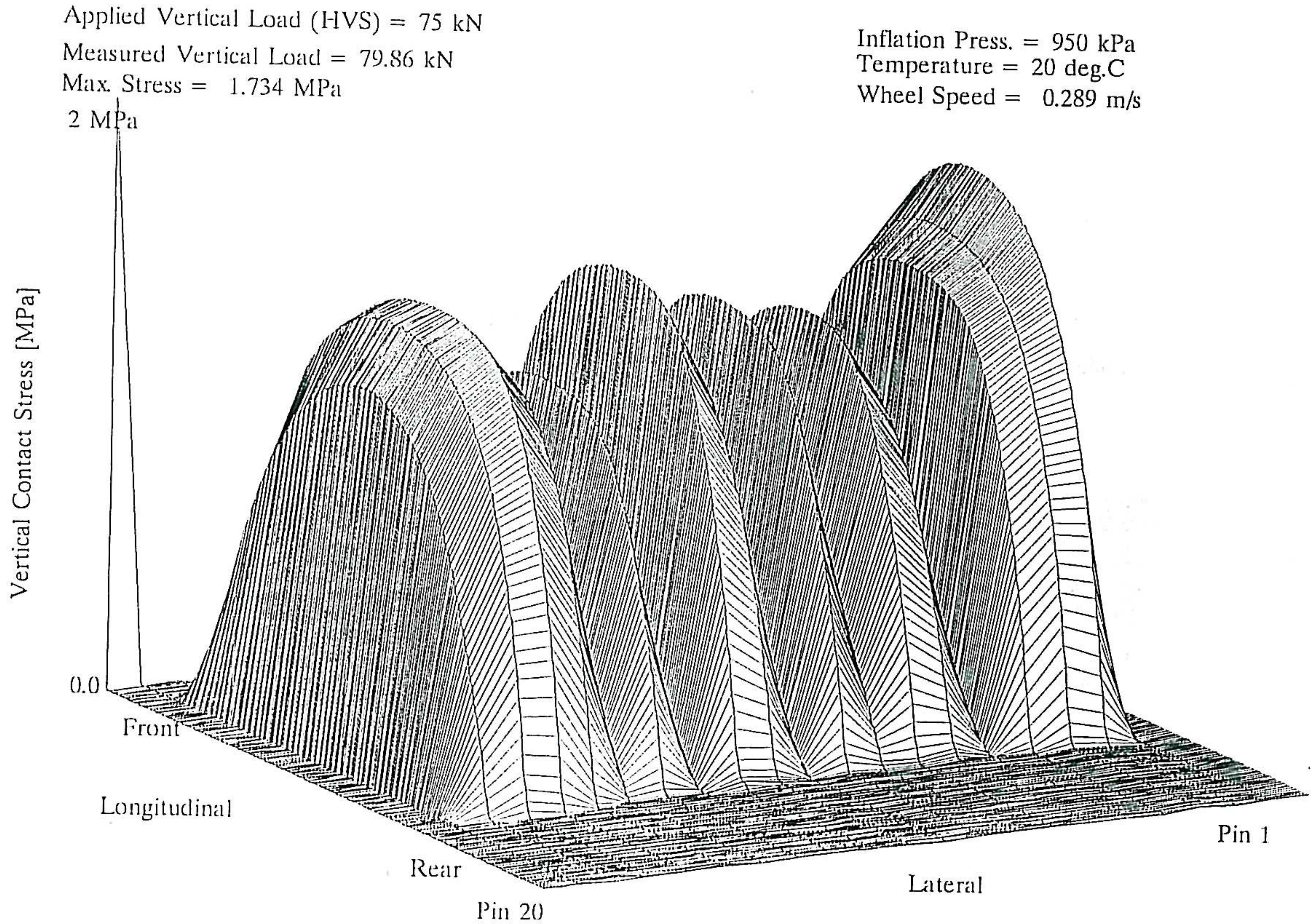
Inflation Press. = 950 kPa
Temperature = 21 deg.C
Wheel Speed = 0.289 m/s



New Bridgestone 425/65R22.5 R164BZ

Filename : nnsc95ax

FIGURE E13X



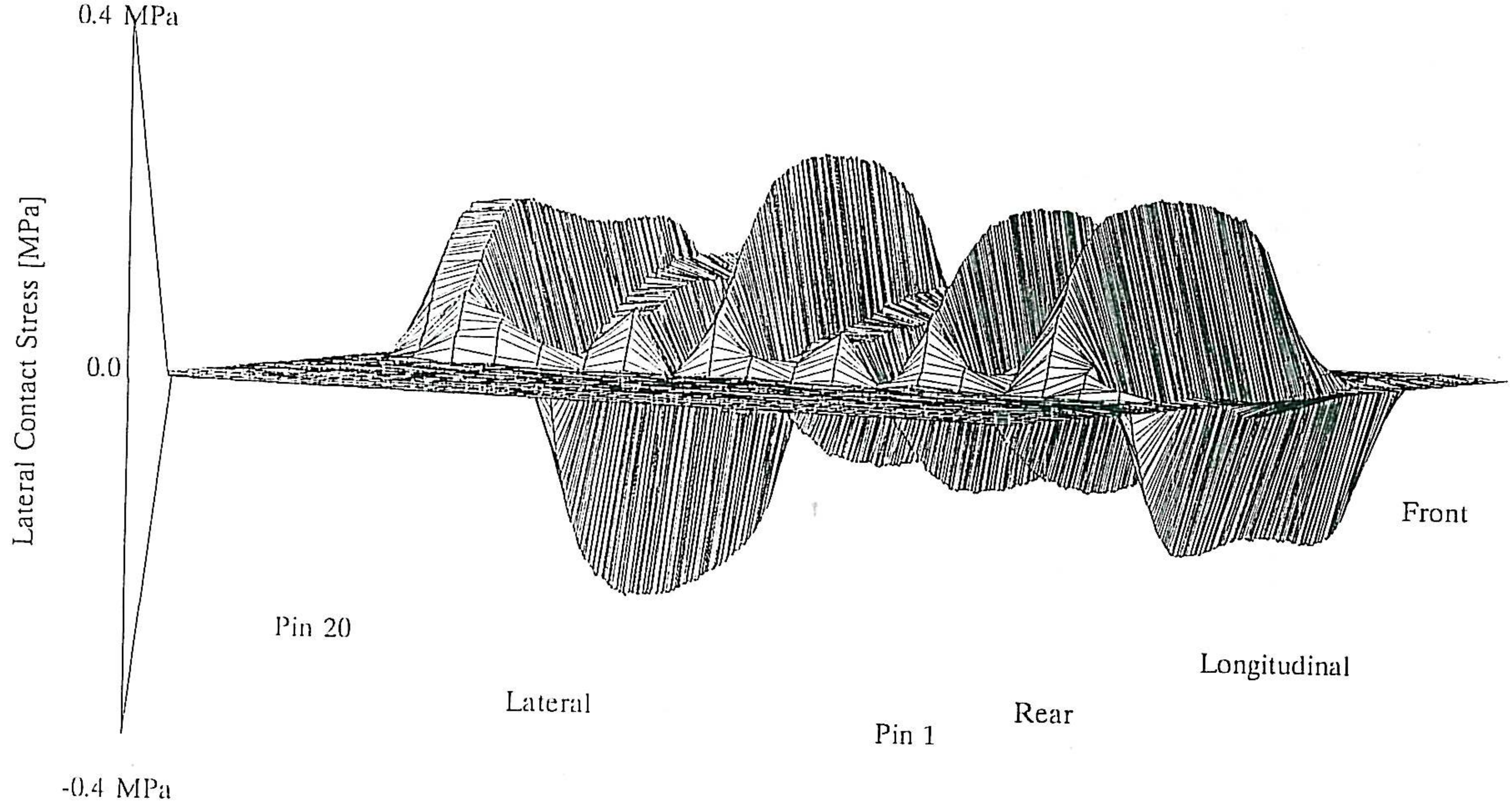
New Bridgestone 425/65R22.5 R164BZ

Filename : nnsc97az

FIGURE E14Z

Applied Vertical Load (HVS) = 75 kN
Measured Lateral Load = 1.941 kN
Max. Stress = 0.2376 MPa
Min. Stress = -0.2631 MPa

Inflation Press. = 950 kPa
Temperature = 20 deg.C
Wheel Speed = 0.289 m/s



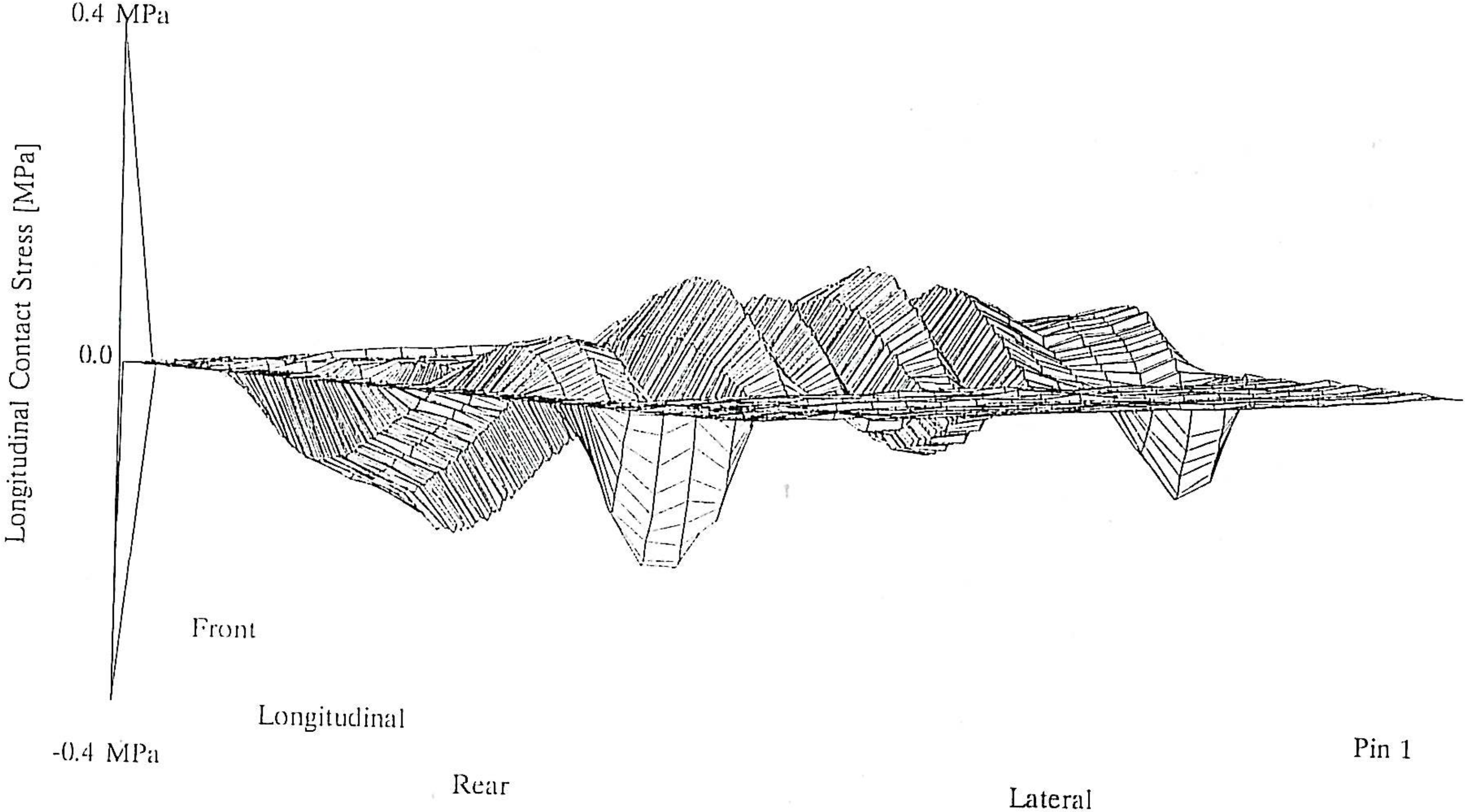
Filename : nnsc97ay

New Bridgestone 425/65R22.5 R164BZ

FIGURE E14Y

Applied Vertical Load (HVS) = 75 kN
Measured Longitudinal Load = -0.3696 kN
Max. Stress = 0.1362 MPa
Min. Stress = -0.203 MPa

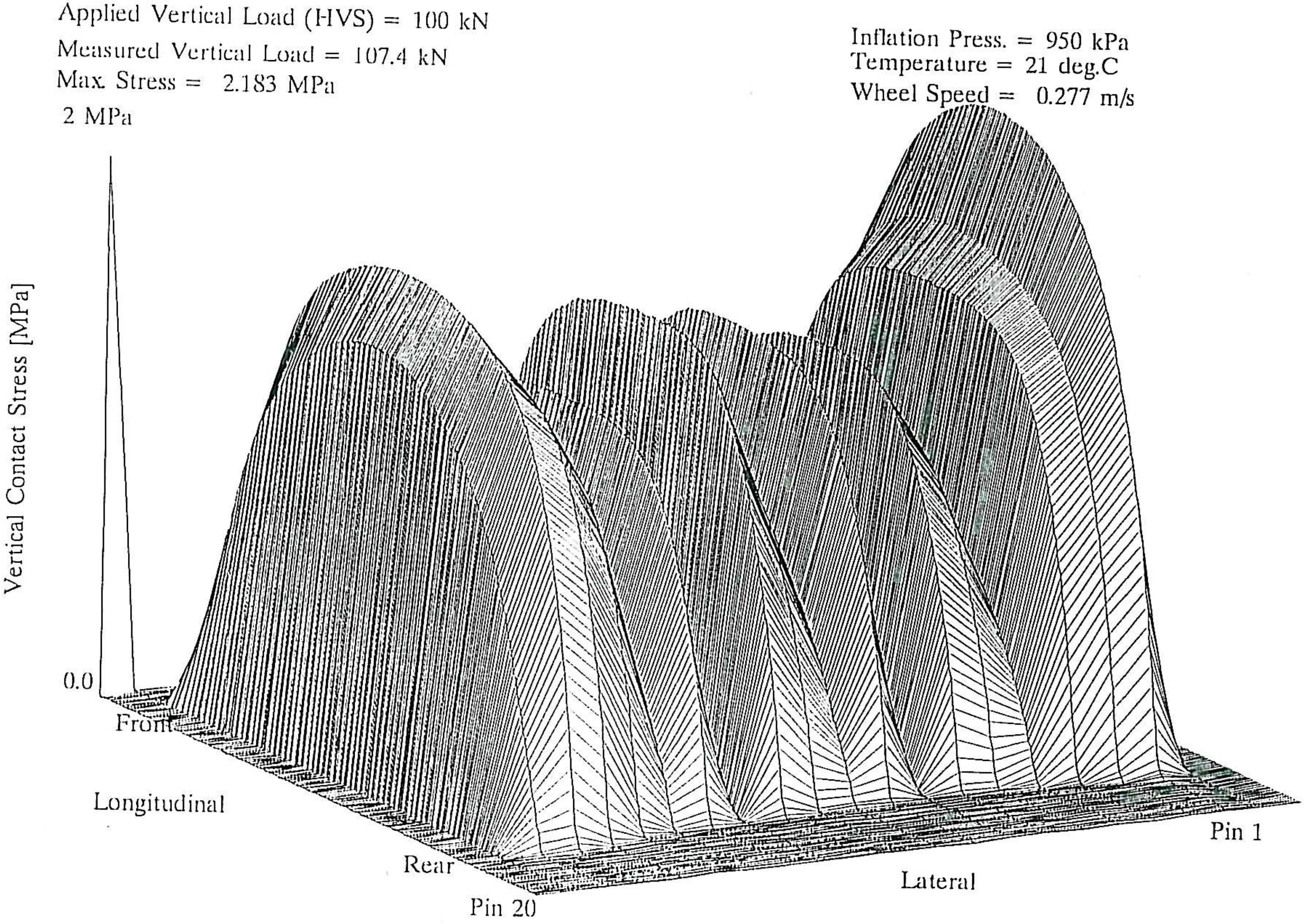
Inflation Press. = 950 kPa
Temperature = 20 deg.C
Wheel Speed = 0.289 m/s



Filename : nnsc97ax

New Bridgestone 425/65R22.5 R164BZ

FIGURE E14X



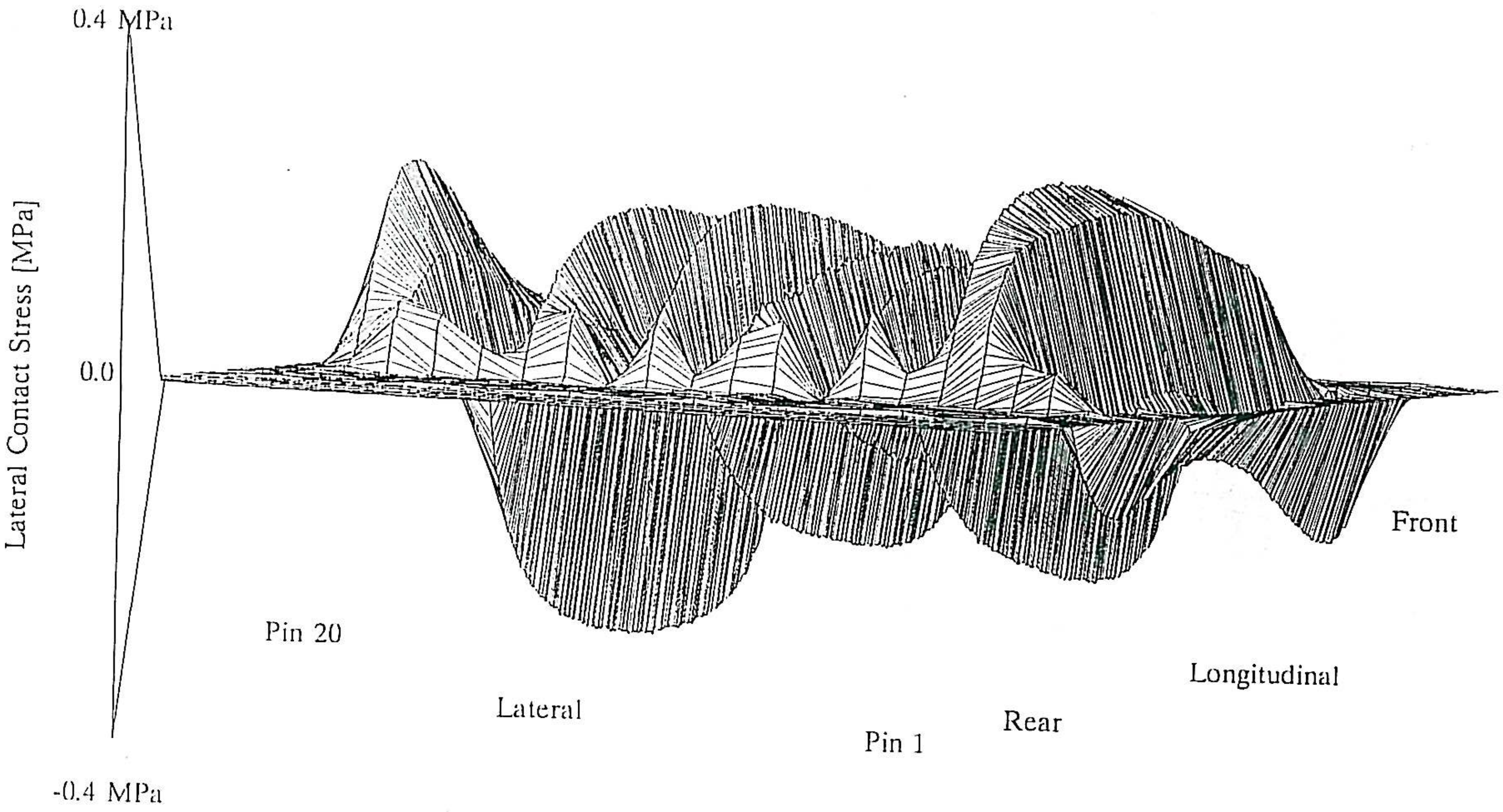
New Bridgestone 425/65R22.5 R164BZ

FIGURE E15Z

Filename : nnsc91az

Applied Vertical Load (HVS) = 100 kN
Measured Lateral Load = 1.34 kN
Max. Stress = 0.2385 MPa
Min. Stress = -0.3005 MPa

Inflation Press. = 950 kPa
Temperature = 21 deg.C
Wheel Speed = 0.277 m/s



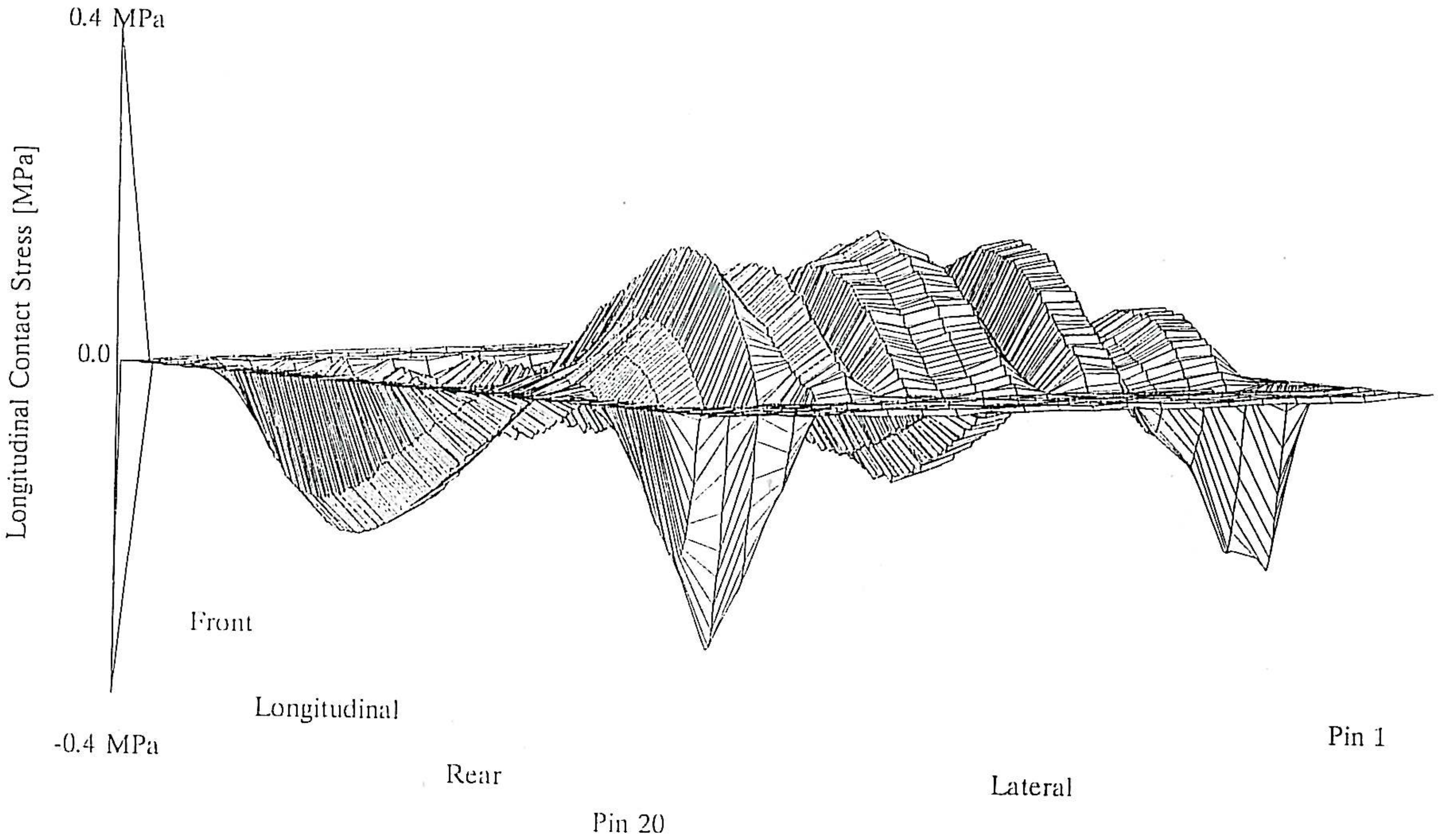
Filename : nnsc91ay

New Bridgestone 425/65R22.5 R164BZ

FIGURE E15Y

Applied Vertical Load (HVS) = 100 kN
Measured Longitudinal Load = -0.1637 kN
Max. Stress = 0.1851 MPa
Min. Stress = -0.2977 MPa

Inflation Press. = 950 kPa
Temperature = 21 deg.C
Wheel Speed = 0.277 m/s



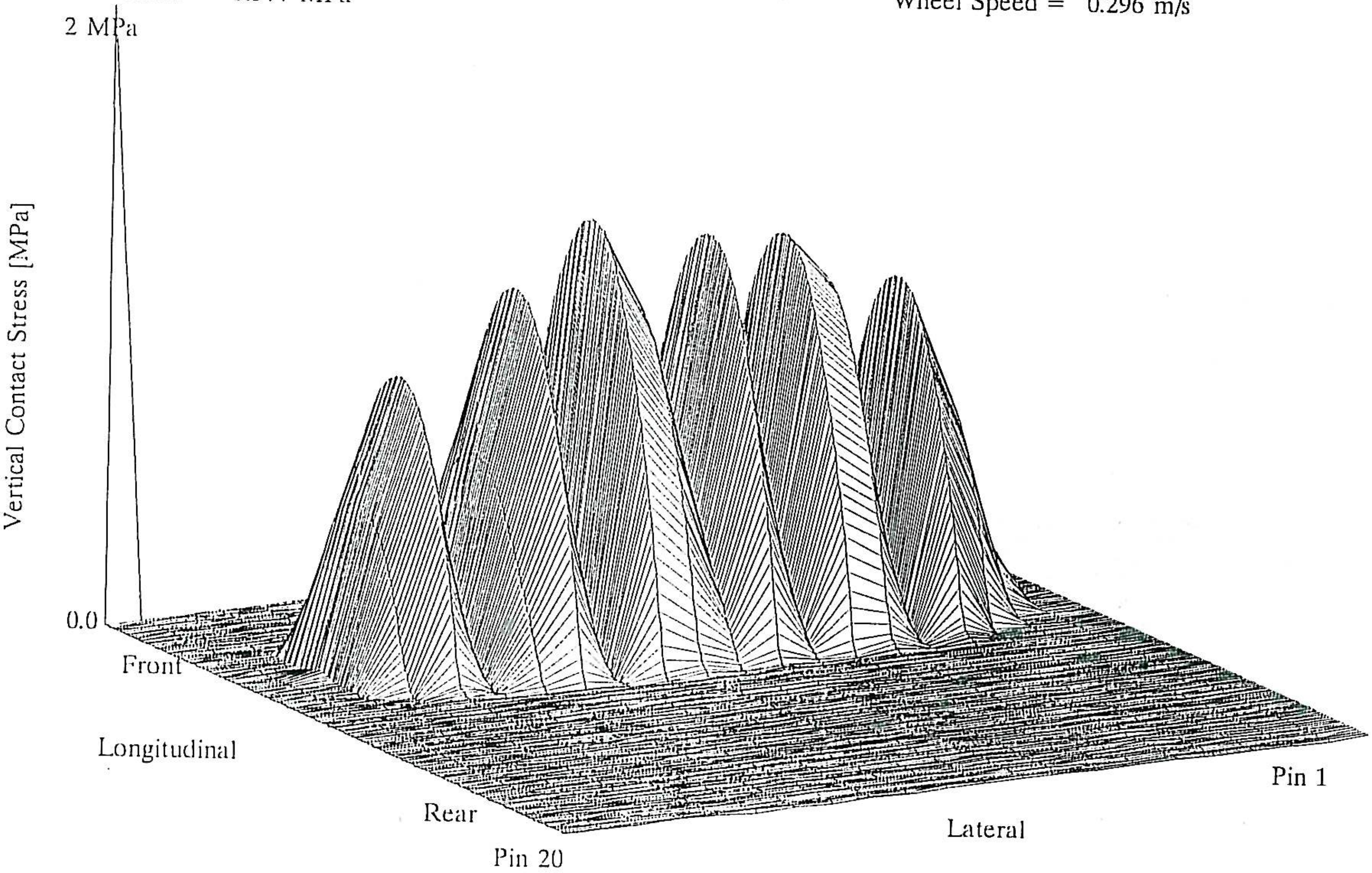
New Bridgestone 425/65R22.5 R164BZ

Filename : nnsc91ax

FIGURE E15X

Applied Vertical Load (HVS) = 25 kN
Measured Vertical Load = 22.08 kN
Max. Stress = 1.377 MPa

Inflation Press. = 1100 kPa
Temperature = 17 deg.C
Wheel Speed = 0.296 m/s



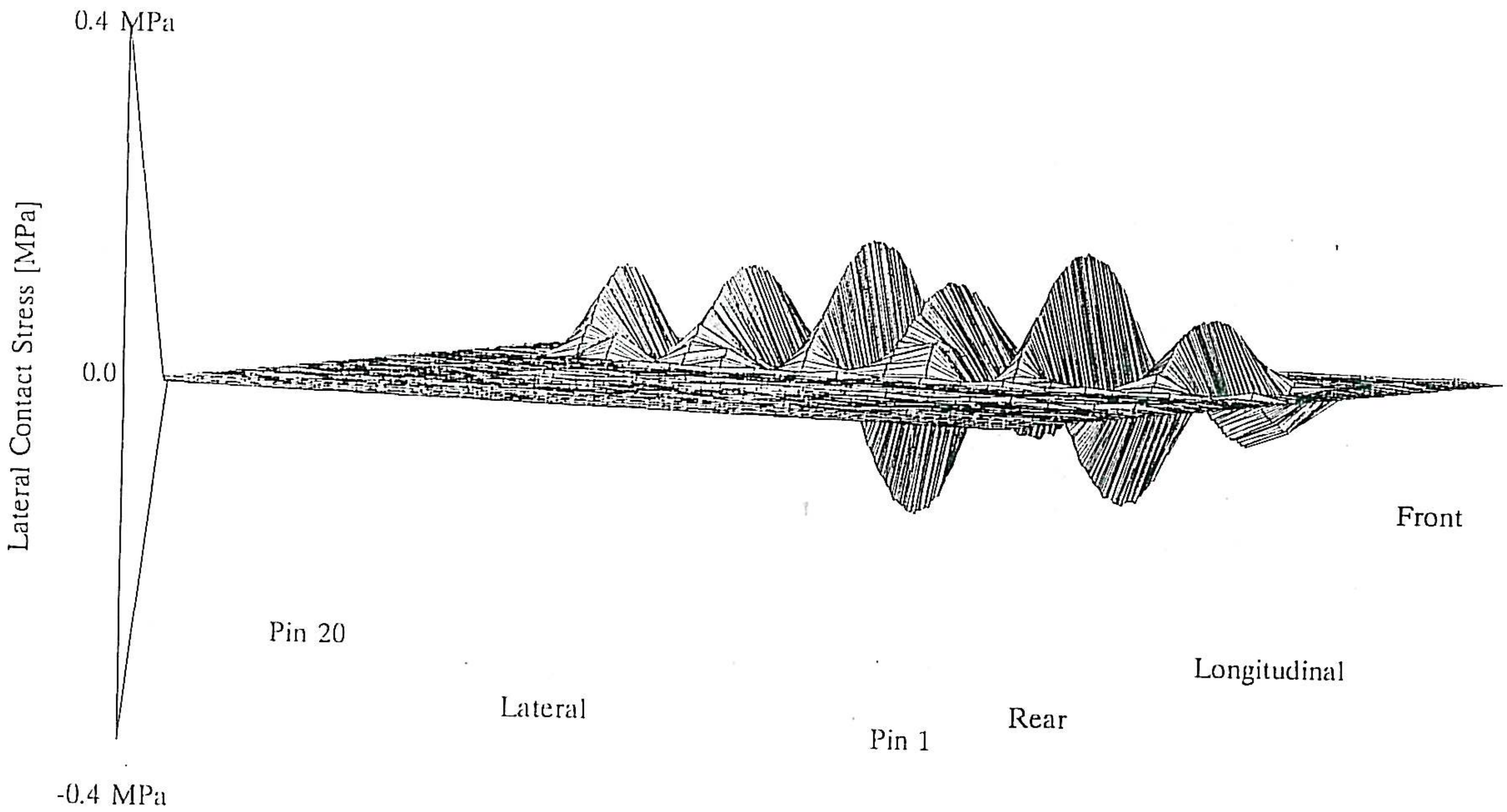
New Bridgestone 425/65R22.5 R164BZ

Filename : nnsc12az

FIGURE E16Z

Applied Vertical Load (HVS) = 25 kN
Measured Lateral Load = 0.2153 kN
Max. Stress = 0.1413 MPa
Min. Stress = -0.1596 MPa

Inflation Press. = 1100 kPa
Temperature = 17 deg.C
Wheel Speed = 0.296 m/s



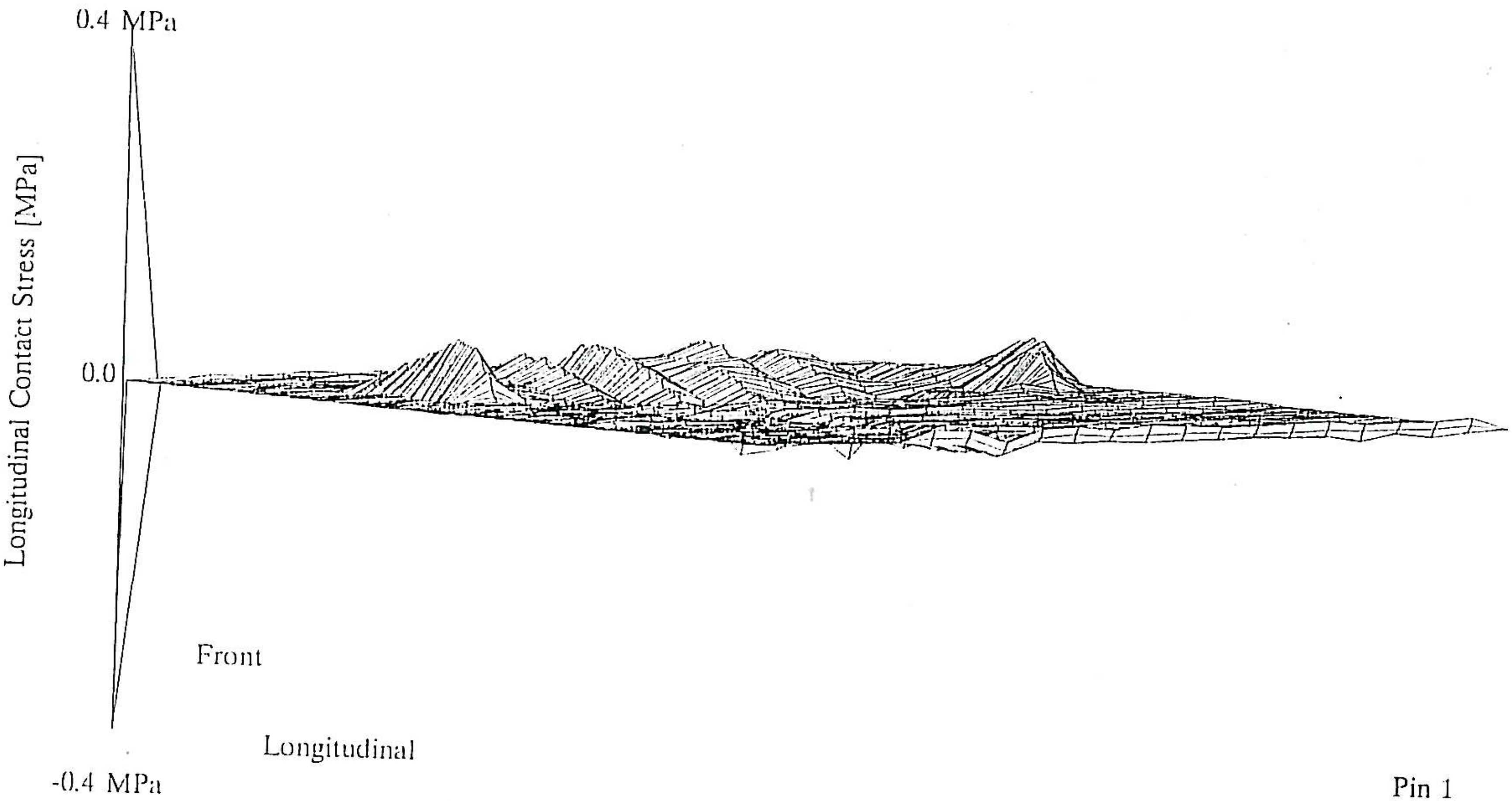
Filename : nnsc12ay

New Bridgestone 425/65R22.5 R164BZ

FIGURE E16Y

Applied Vertical Load (HVS) = 25 kN
Measured Longitudinal Load = 0.08637 kN
Max. Stress = 0.07168 MPa
Min. Stress = -0.06685 MPa

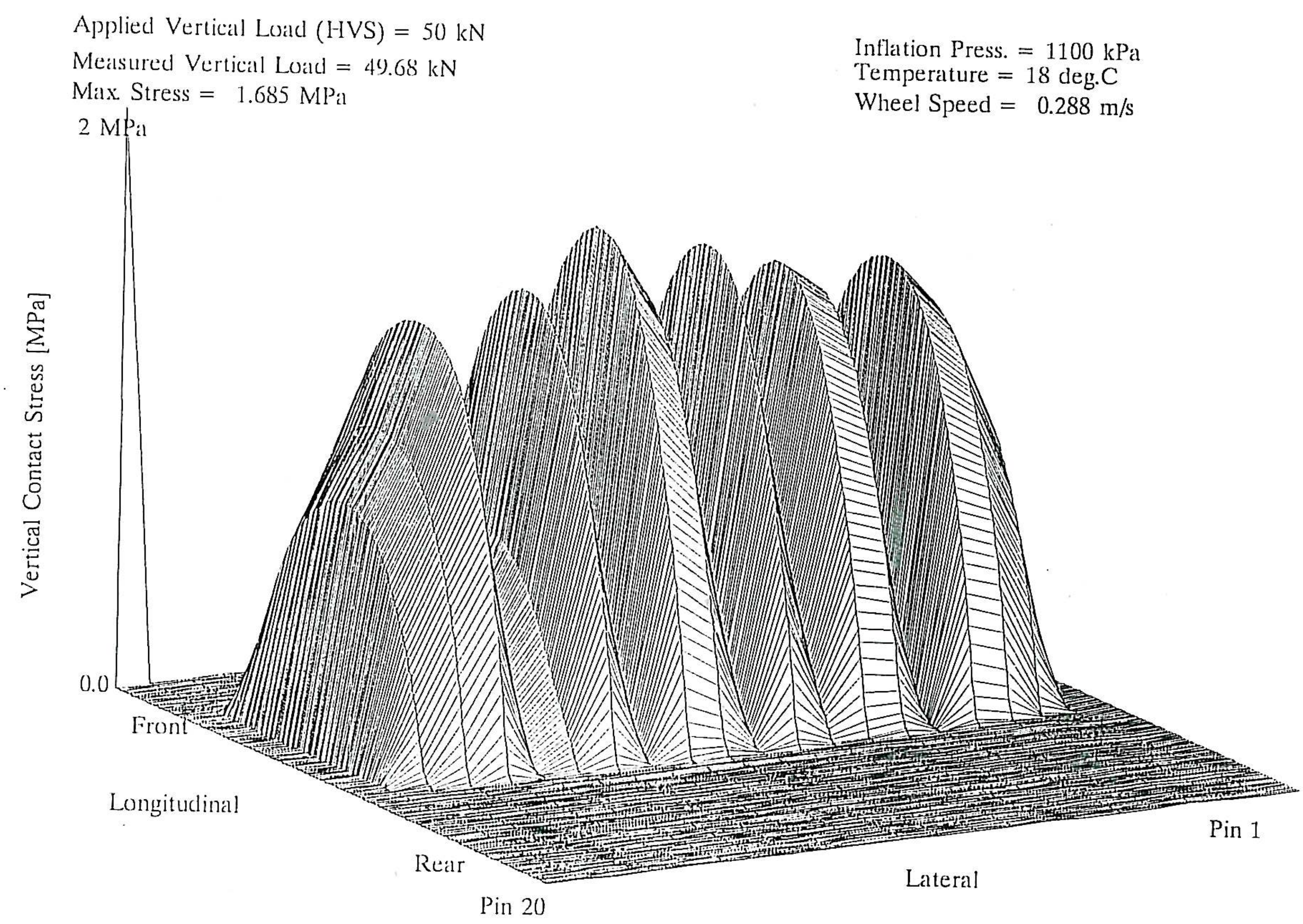
Inflation Press. = 1100 kPa
Temperature = 17 deg.C
Wheel Speed = 0.296 m/s



New Bridgestone 425/65R22.5 R164BZ

Filename : nnsc12ax

FIGURE E16X



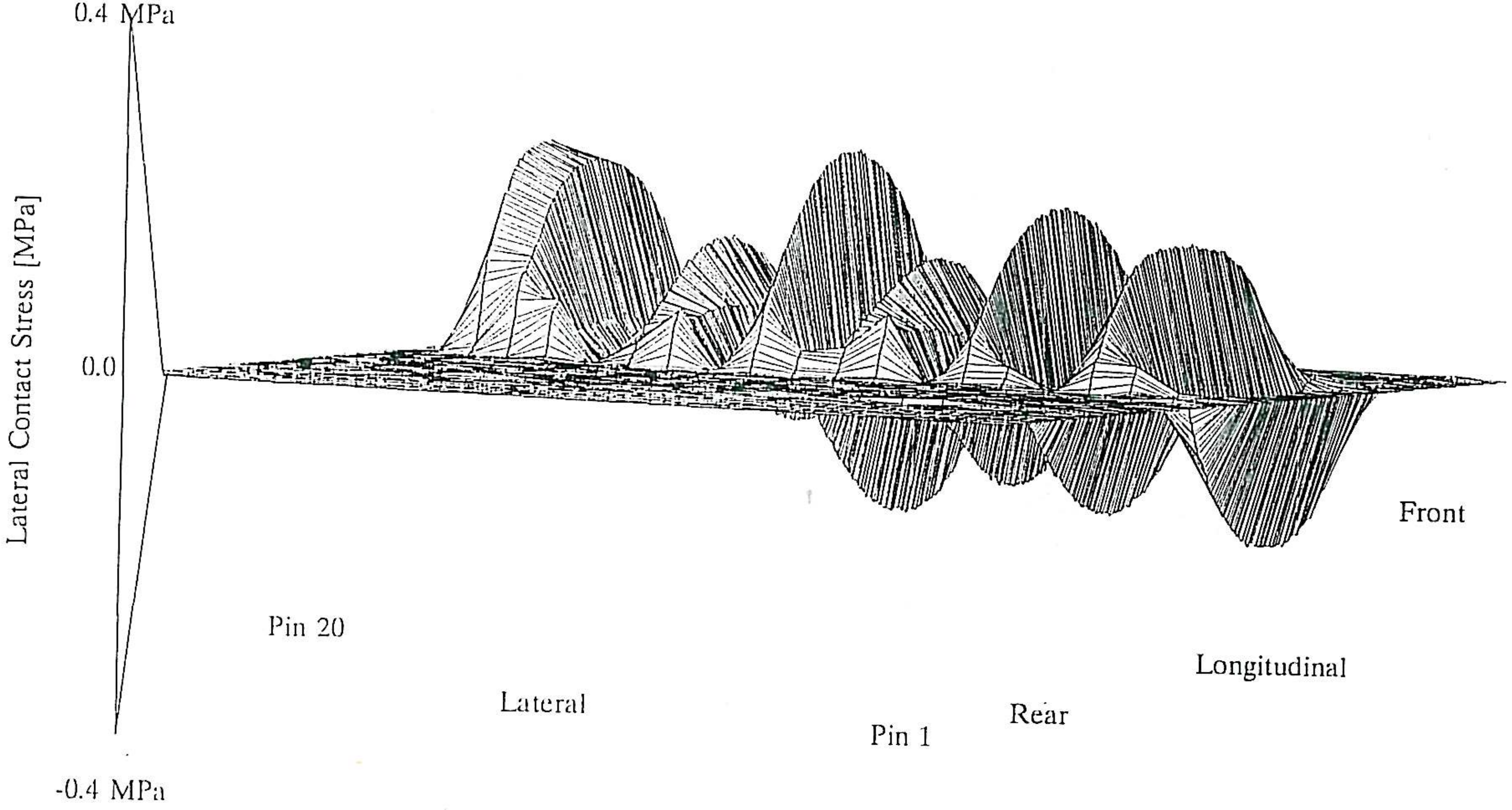
New Bridgestone 425/65R22.5 R164BZ

Filename : nnsc15az

FIGURE E17Z

Applied Vertical Load (HVS) = 50 kN
Measured Lateral Load = 1.855 kN
Max. Stress = 0.2372 MPa
Min. Stress = -0.1764 MPa

Inflation Press. = 1100 kPa
Temperature = 18 deg.C
Wheel Speed = 0.288 m/s



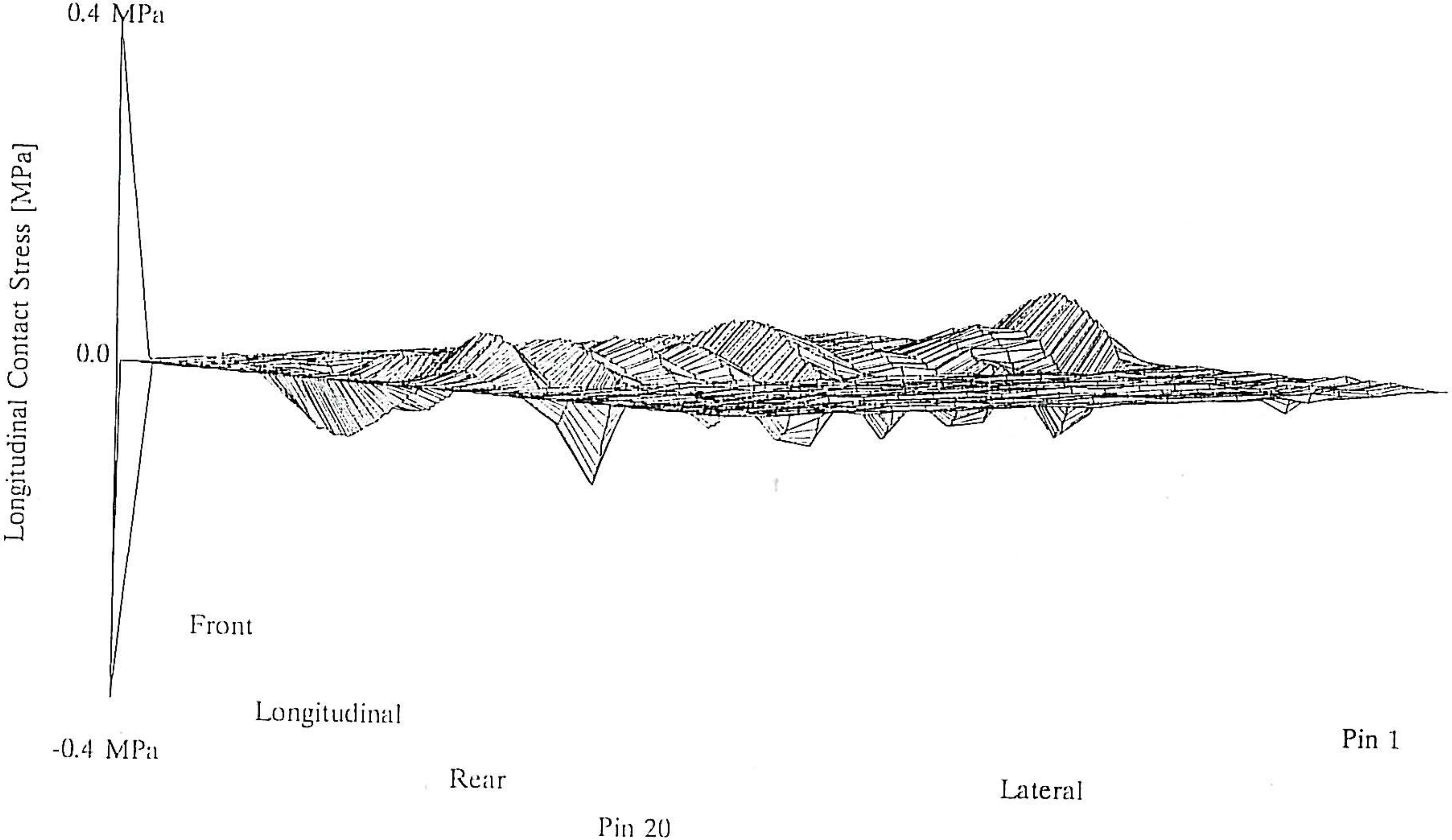
Filename : nnscl5ay

New Bridgestone 425/65R22.5 R164BZ

FIGURE E17Y

Applied Vertical Load (HVS) = 50 kN
Measured Longitudinal Load = 0.3746 kN
Max. Stress = 0.08586 MPa
Min. Stress = -0.1163 MPa

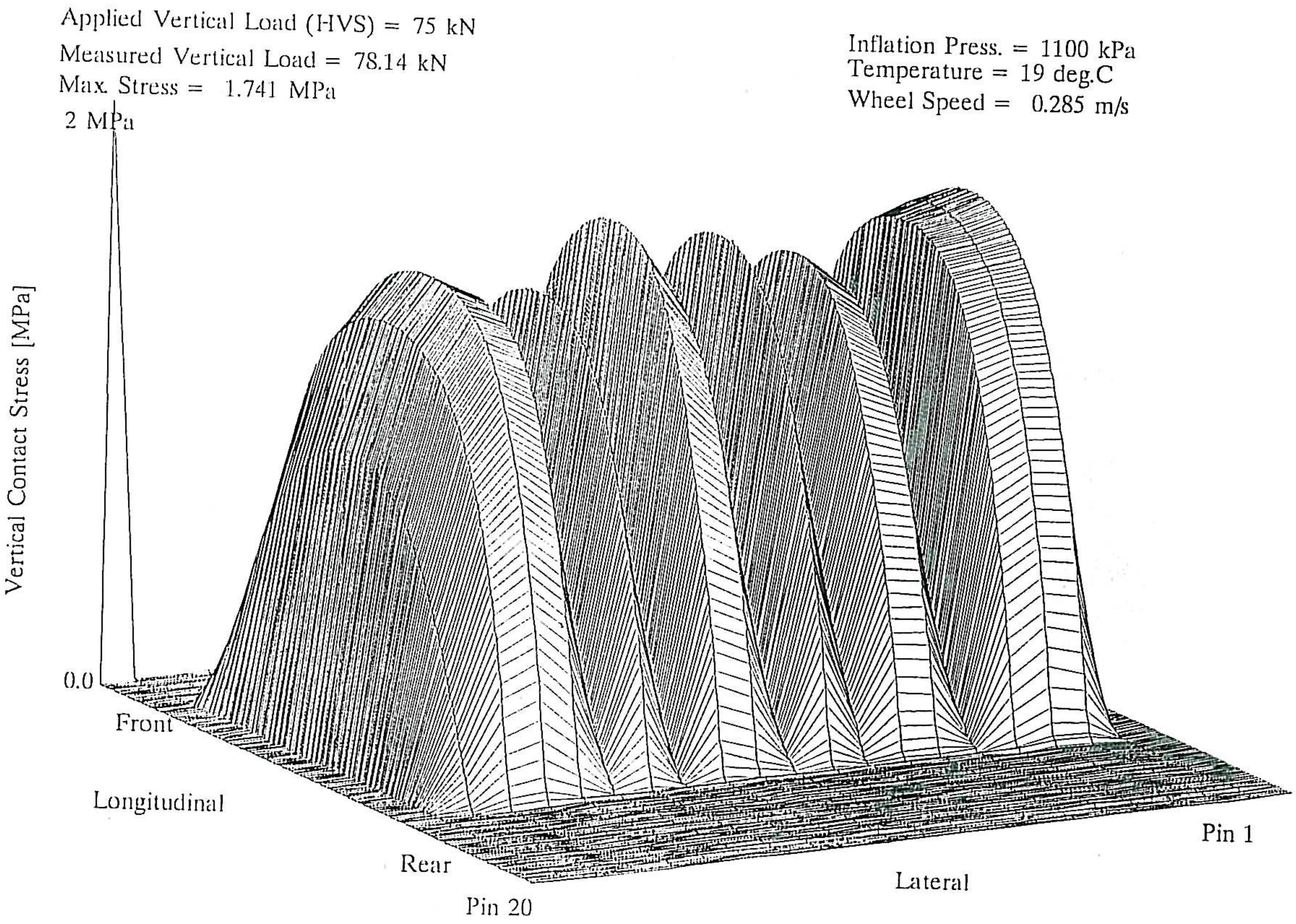
Inflation Press. = 1100 kPa
Temperature = 18 deg.C
Wheel Speed = 0.288 m/s



New Bridgestone 425/65R22.5 R164BZ

Filename : nnscl5ax

FIGURE E17X



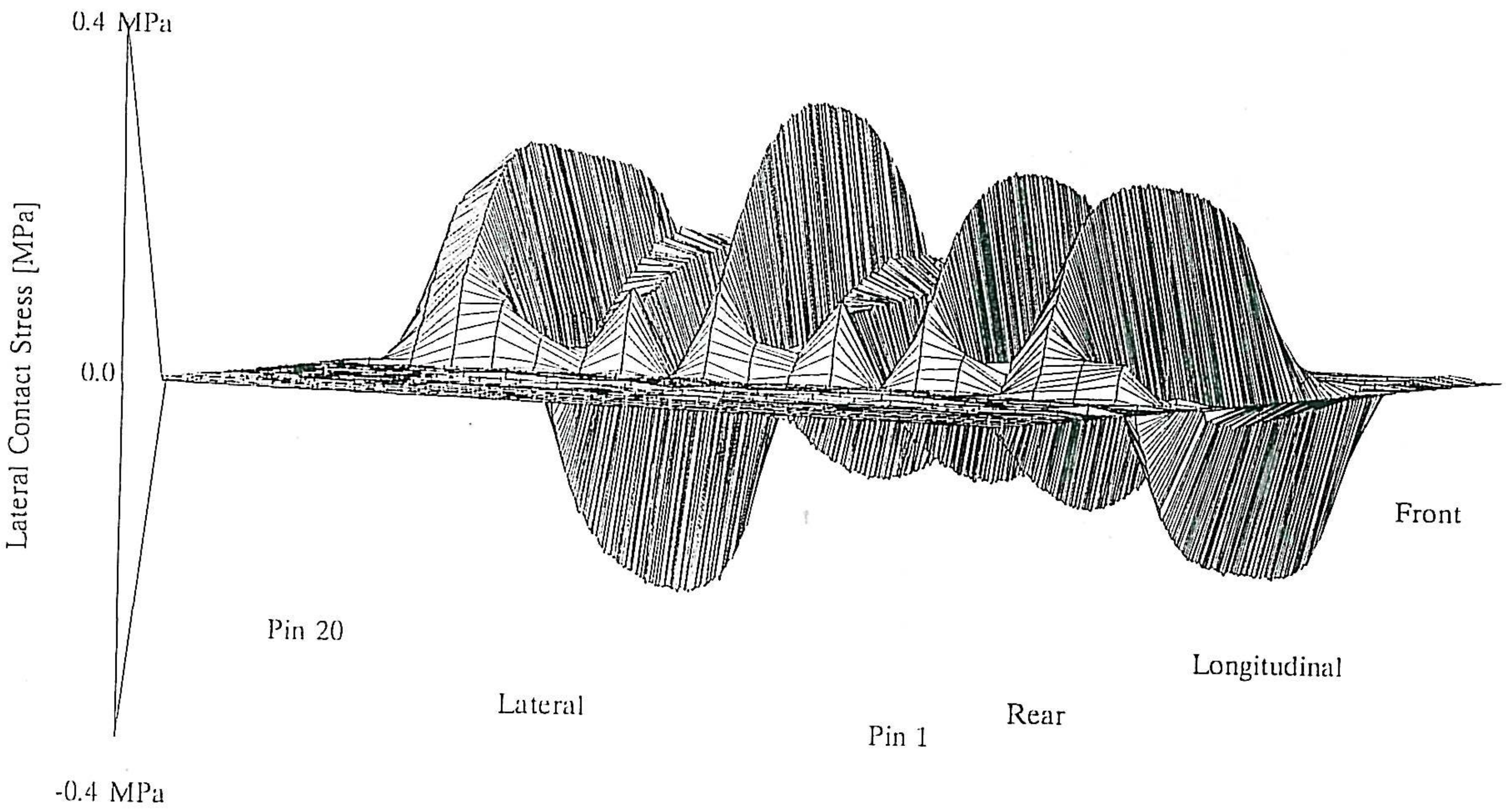
New Bridgestone 425/65R22.5 R164BZ

Filename : nnsc17az

FIGURE E18Z

Applied Vertical Load (HVS) = 75 kN
Measured Lateral Load = 3.327 kN
Max. Stress = 0.2985 MPa
Min. Stress = -0.2618 MPa

Inflation Press. = 1100 kPa
Temperature = 19 deg.C
Wheel Speed = 0.285 m/s



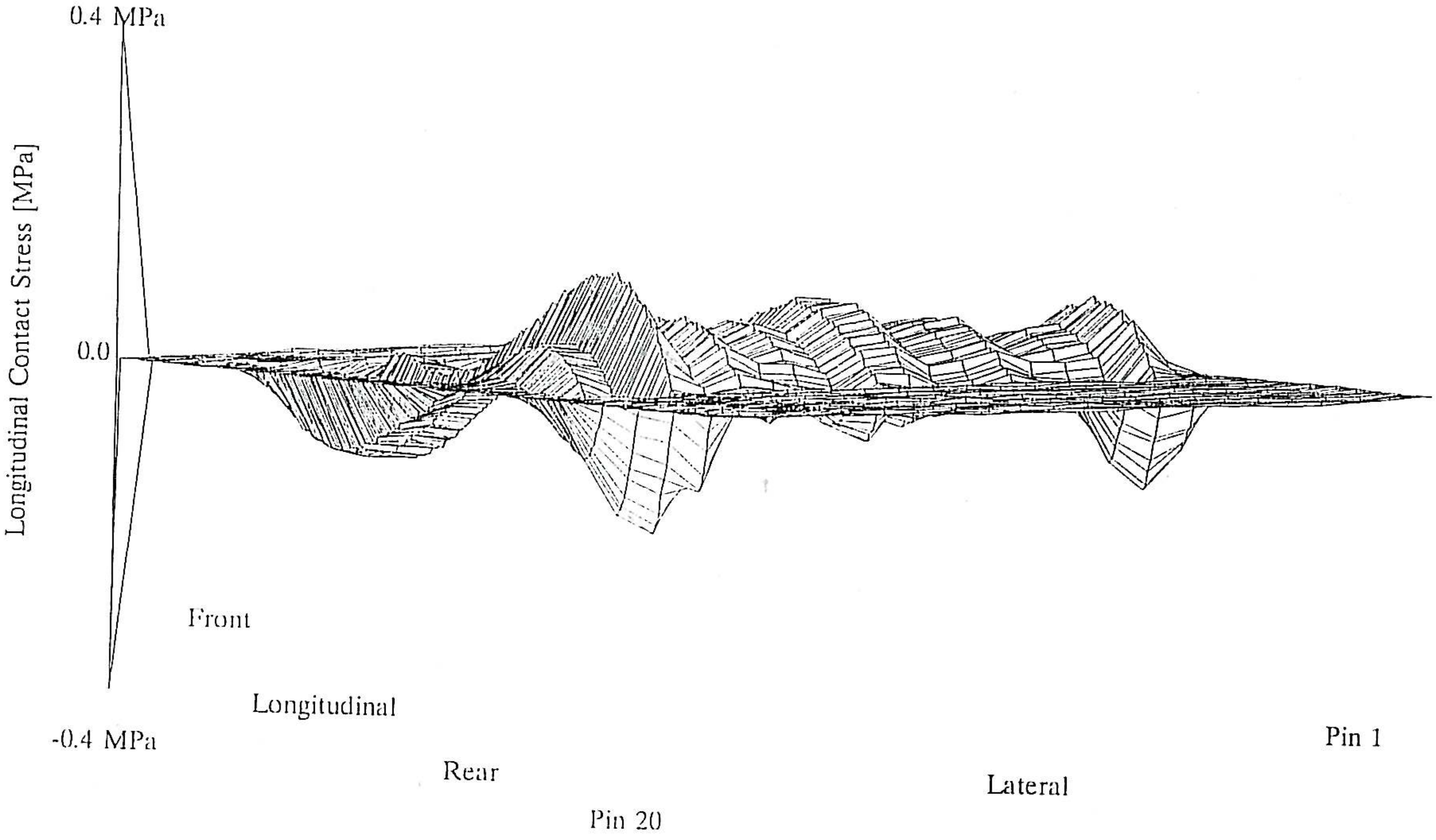
Filename : nnscl7ay

New Bridgestone 425/65R22.5 R164BZ

FIGURE E18Y

Applied Vertical Load (HVS) = 75 kN
Measured Longitudinal Load = -0.09764 kN
Max. Stress = 0.1368 MPa
Min. Stress = -0.1714 MPa

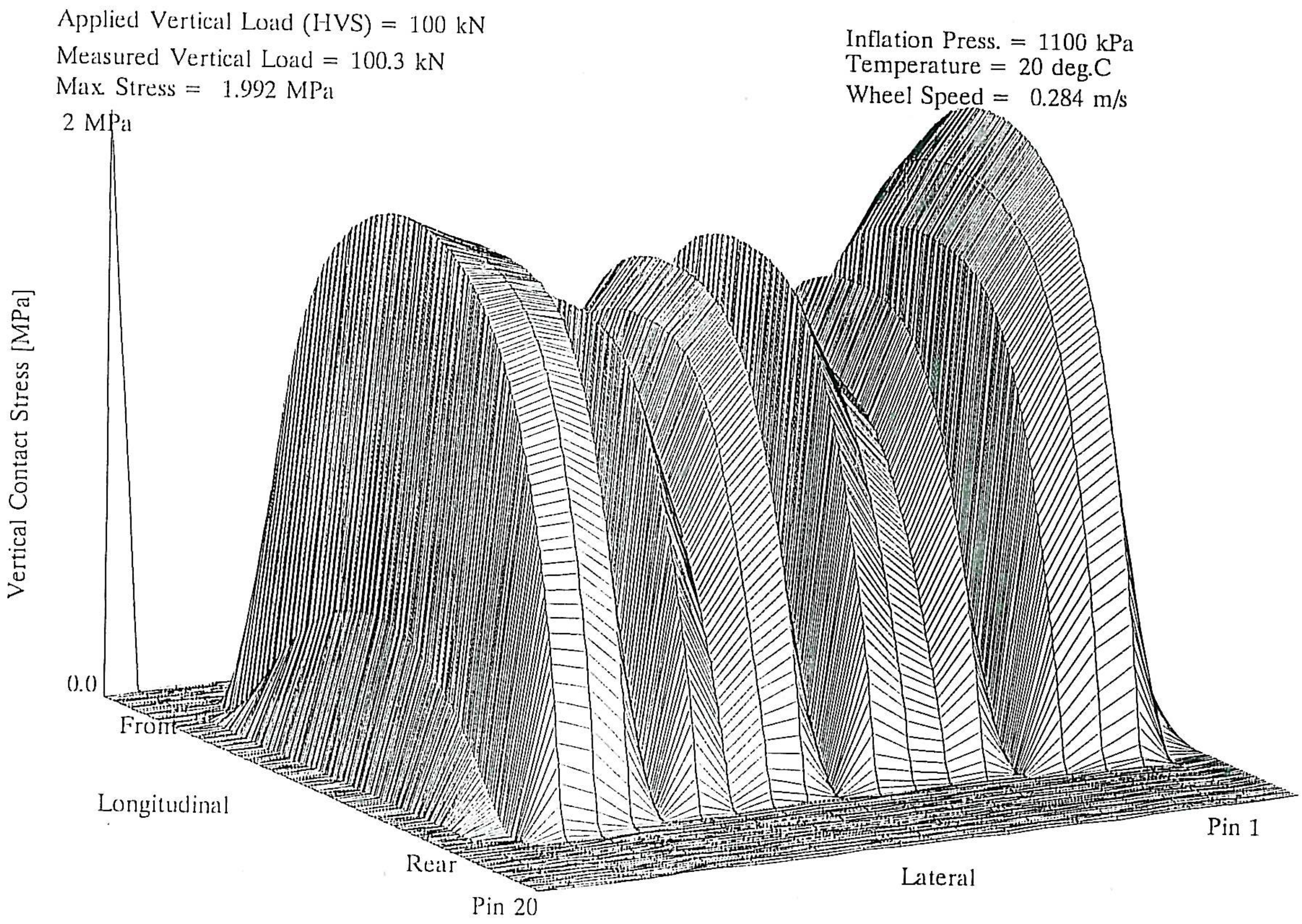
Inflation Press. = 1100 kPa
Temperature = 19 deg.C
Wheel Speed = 0.285 m/s



Filename : nnsc17ax

New Bridgestone 425/65R22.5 R164BZ

FIGURE E18X



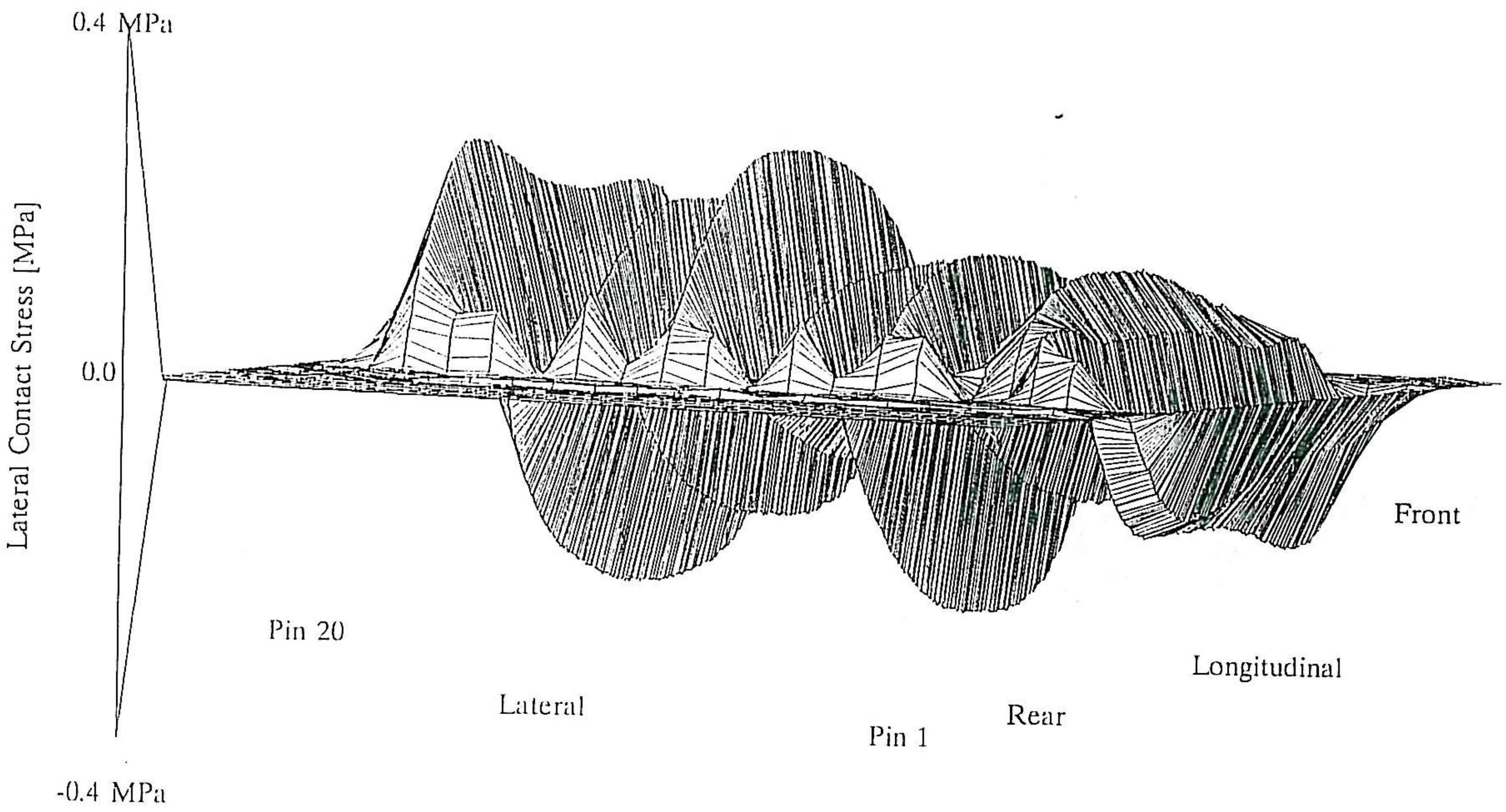
New Bridgestone 425/65R22.5 R164BZ

Filename : nnsc11az

FIGURE E19Z

Applied Vertical Load (HVS) = 100 kN
Measured Lateral Load = 0.8731 kN
Max. Stress = 0.252 MPa
Min. Stress = -0.2601 MPa

Inflation Press. = 1100 kPa
Temperature = 20 deg.C
Wheel Speed = 0.284 m/s



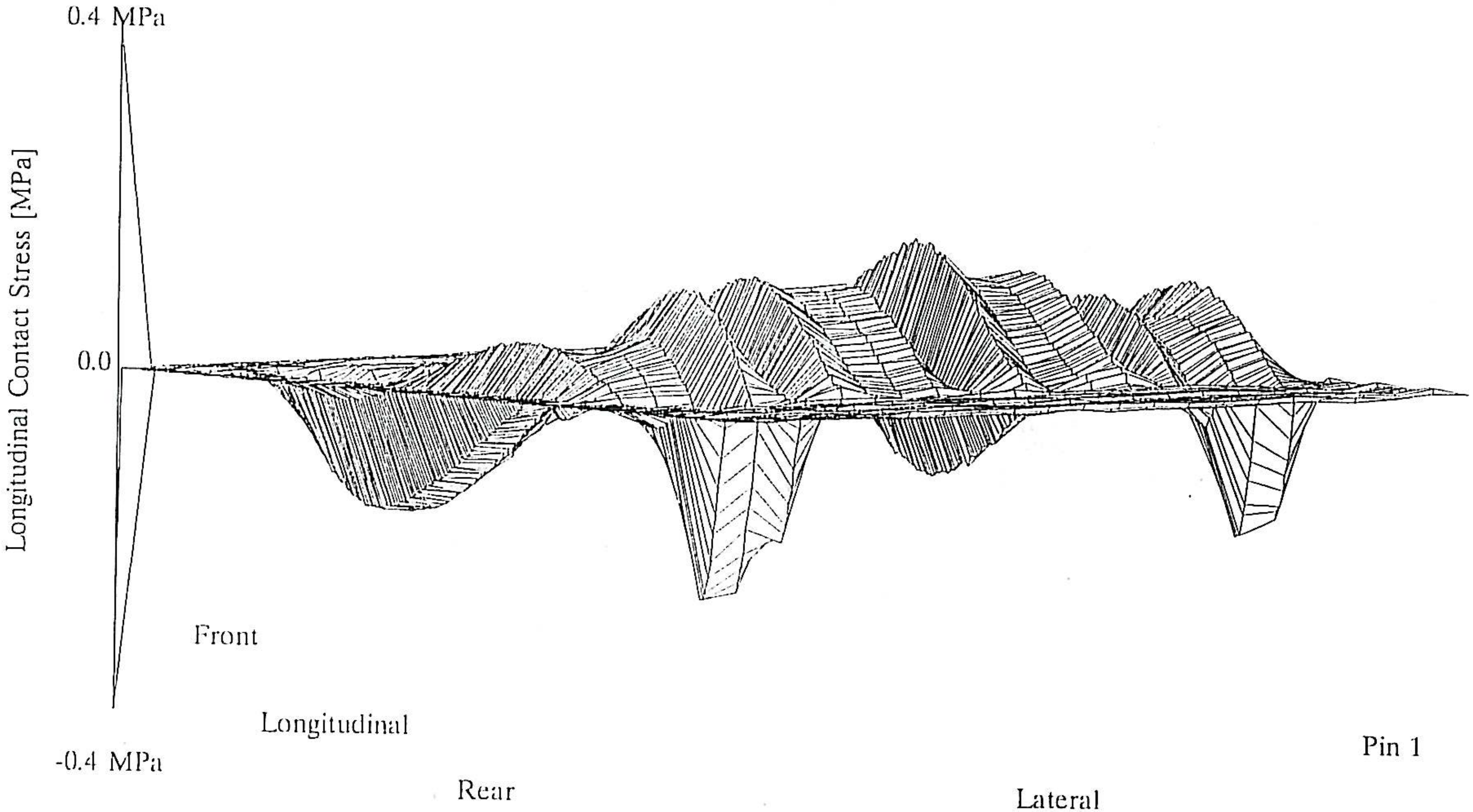
Filename : nnsc1lay

New Bridgestone 425/65R22.5 R164BZ

FIGURE E19Y

Applied Vertical Load (HVS) = 100 kN
Measured Longitudinal Load = 0.9565 kN
Max. Stress = 0.1729 MPa
Min. Stress = -0.2283 MPa

Inflation Press. = 1100 kPa
Temperature = 20 deg.C
Wheel Speed = 0.284 m/s



New Bridgestone 425/65R22.5 R164BZ

Filename : nnsc11ax

FIGURE E19X

APPENDIX F:

3-DIMENSIONAL (3-D) PLOTS OF STRESSES MEASURED UNDER THE LINTRACK *NEW* BRIDGESTONE 425/65 R 22.5 R164BZ TYRE AT "TRAFFIC SPEED"

TABLE 2 (Cont.): HVS4: 3D Stress Sensor Tests on the New Bridgestone R164BZ 425/65 R22.5 PR20 tyre

Legend of filename with tests on NEW tyre : NNSC52AZ.PRN :

TRAFFIC TESTS

N=Netherlands ; N=Lintrack New tyre ; S=Super single ; C=Creep speed;(or T=Traffic (HVS) speed) ;

5=Cold inflation pressure 500 kPa ; 2=Vertical load 25 kN : A=Test (repeat)1 (or B=repeat 2 or C=repeat 3);

Z=Vertical stress (or X=Transverse, or Y=Longitudinal).

DATE 16/07/96

Speed Sensor distance = 1.0m

NETNEW.WK1

HVS POSITION

Traffic side

Traffic side | Cabin end

Caravan side

Filename *.prn		PRESSURE (kPa)	HVS (kN)	LOAD Box (kN)	TEMP °C	SPEED (m/s)	Hz (sam/sec)	Figure no.	Pin numbers across loadcell A = ALL DIRECTIONS MISSED THE PIN																				3d-Loadcell Total load (kN)
									1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
NNST52	Az/x/y	500	25	23.4	20	3.222	1500	F1	A				A															A	24.79
NNST52	Bz/x/y	500	25	23.4	20	3.188	1500	-	A				A															A	26.12
NNST52	Cz/x/y	500	25	23.4	20	3.261	1500	-	A												A							A	26.35
NNST55	Az/x/y	500	50	48.2	20	3.131	1500	F2					A														A	A	50.82
NNST55	Bz/x/y	500	50	48.2	20	3.162	1500	-					A					A					A				A	A	50.69
NNST55	Cz/x/y	500	50	48.2	20	3.142	1500	-	A																			A	53.80
NNST57	Az/x/y	500	75	74.5	21	3.059	1000	F3																				A	75.90
NNST57	Bz/x/y	500	75	74.5	21	3.009	1000	-										A					A					A	78.00
NNST57	Cz/x/y	500	75	74.5	21	3.096	1000	-																				A	74.98
NNST72	Az/x/y	700	25	25.1	21	2.880	1500	F4	A																			A	27.33
NNST72	Bz/x/y	700	25	24.8	21	2.832	1500	-	A				A															A	26.10
NNST72	Cz/x/y	700	25	24.8	21	2.857	1500	-	A												A							A	27.70
NNST75	Az/x/y	700	50	48.8	21	2.798	1500	F5					A															A	50.13
NNST75	Bz/x/y	700	50	48.8	21	2.889	1500	-					A															A	50.18
NNST75	Cz/x/y	700	50	48.8	21	2.783	1500	-	A																			A	52.98
NNST77	Az/x/y	700	75	74.1	21	2.955	1000	F6	A																			A	76.42
NNST77	Bz/x/y	700	75	74.1	21	2.917	1000	-																				A	78.07
NNST77	Cz/x/y	700	75	74.1	21	2.972	1000	-					A					A					A					A	74.44
NNST71	Az/x/y	700	100	100.1	21	2.815	1000	F7																				A	102.02
NNST71	Bz/x/y	700	100	100.1	21	3.004	1000	-					A					A					A					A	104.35
NNST71	Cz/x/y	700	100	101.0	21	2.902	1000	-																				A	105.22
NNT902	Az/x/y	900	25	24.9	21	3.347	1500	F8	A				A								A							A	25.86
NNT902	Bz/x/y	900	25	24.9	21	3.394	1500	-	A							A												A	27.91
NNT902	Cz/x/y	900	25	24.9	21	3.389	1500	-	A							A								A				A	25.81
NNT905	Az/x/y	900	50	47.7	22	3.251	1500	F9	A							A												A	51.47
NNT905	Bz/x/y	900	50	47.7	22	3.323	1500	-	A							A												A	53.09
NNT905	Cz/x/y	900	50	47.7	22	3.320	1500	-	A																			A	52.54
NNT907	Az/x/y	900	75	73.8	22	3.401	1000	F10	A																			A	82.71
NNT907	Bz/x/y	900	75	73.8	22	3.402	1000	-	A														A					A	76.65
NNT907	Cz/x/y	900	75	73.8	22	3.417	1000	-	A												A							A	81.60
NNT901	Az/x/y	900	100	101.2	22	3.118	1000	F11																				A	105.43
NNT901	Bz/x/y	900	100	101.2	22	3.357	1000	-																				A	109.30
NNT901	Cz/x/y	900	100	101.2	22	3.298	1000	-													A							A	110.10

TABLE 2 (Cont.): HVS4: 3D Stress Sensor Tests on the New Bridgestone R164BZ 425/65 R22.5 PR20 tyre

TRAFFIC TESTS

Legend of filename with tests on NEW tyre : NNSC52AZ.PRN :
N=Netherlands ; N=Lintrack New tyre ; S=Super single ; C=Creep speed;(or T=Traffic (HVS) speed) ;
5=Cold inflation pressure 500 kPa ; 2=Vertical load 25 kN : A=Test (repeat)1 (or B=repeat 2 or C=repeat 3);
Z=Vertical stress (or X=Transverse, or Y=Longitudinal).

DATE 16/07/96

Speed Sensor distance = 1.0m

NETNEW.WK1

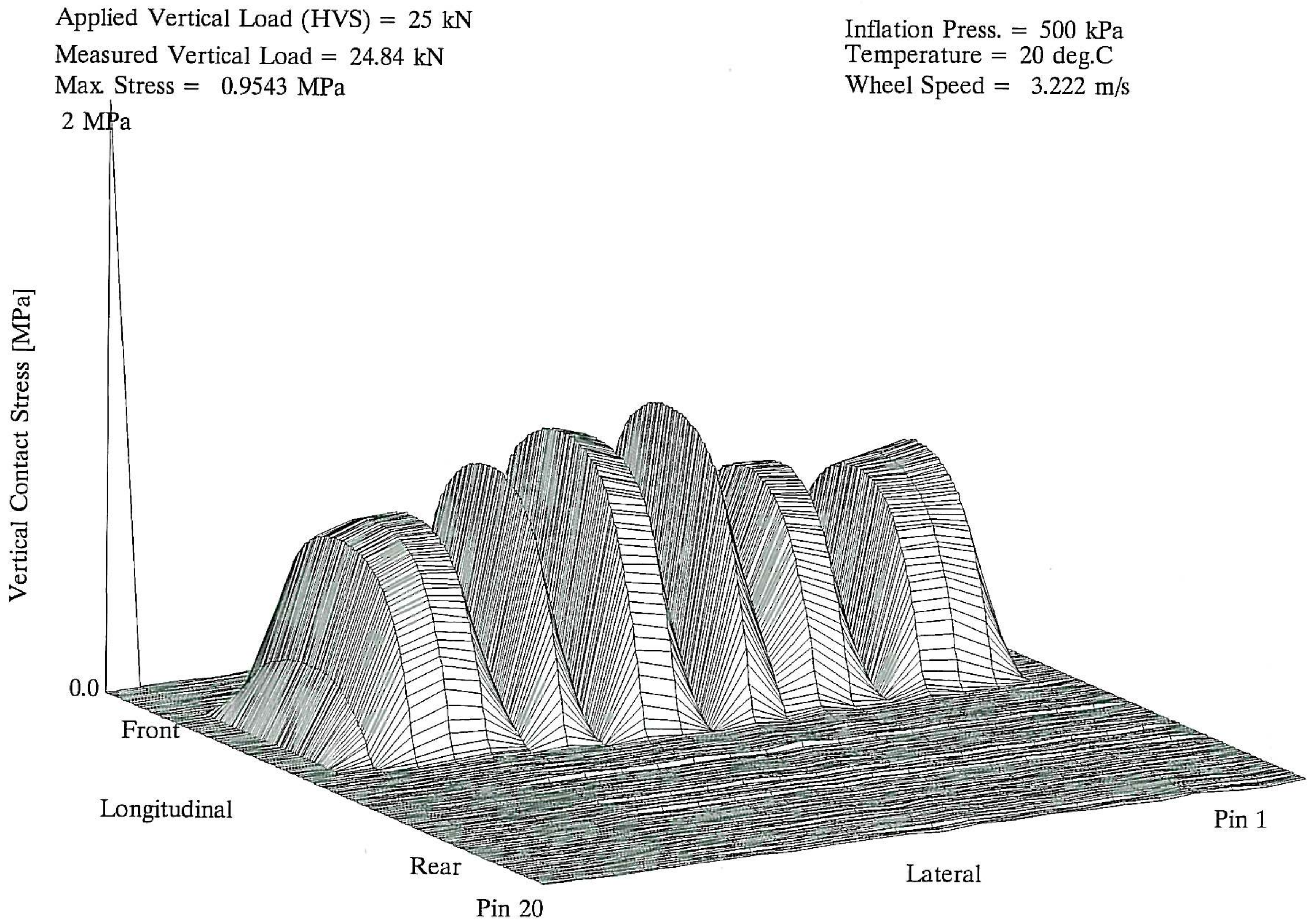
HVS POSITION

Traffic side

Traffic side | Cabin end

Caravan side

Filename		PRESSURE	HVS	LOAD	TEMP	SPEED	Hz	Figure	Pin numbers across loadcell												A = ALL DIRECTIONS MISSED THE PIN								3d-Loadcell
*.prn		(kPa)	(kN)	Box (kN)	°C	(m/s)	(sam/sec)	no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total load (kN)
NNST92	Az/x/y	950	25	24.2	21	3.253	1500	F12	A															A				A	27.49
NNST92	Bz/x/y	950	25	24.2	21	3.144	1500	-	A															A				A	26.36
NNST92	Cz/x/y	950	25	24.2	21	3.314	1500	-	A				A															A	24.84
NNST95	Az/x/y	950	50	48.2	21	3.202	1500	F13	A																			A	52.39
NNST95	Bz/x/y	950	50	48.2	21	3.194	1500	-	A																			A	50.03
NNST95	Cz/x/y	950	50	48.2	21	3.300	1500	-	A							A												A	52.19
NNST97	Az/x/y	950	75	74.1	21	3.406	1000	F14	A																			A	75.72
NNST97	Bz/x/y	950	75	74.1	21	3.323	1000	-	A												A							A	80.32
NNST97	Cz/x/y	950	75	74.1	21	3.319	1000	-																				A	76.43
NNST91	Az/x/y	950	100	101.3	21	3.273	1000	F15	A												A							A	107.19
NNST91	Bz/x/y	950	100	101.3	21	3.269	1000	-	A																			A	105.97
NNST91	Cz/x/y	950	100	101.3	21	3.365	1000	-	A												A							A	99.57
NNST12	Az/x/y	1100	25	23.0	21	3.078	1500	F16	A				A														A	A	26.64
NNST12	Bz/x/y	1100	25	23.4	21	3.014	1500	-	A																		A	A	27.55
NNST12	Cz/x/y	1100	25	23.4	21	3.048	1500	-	A																		A	A	25.87
NNST15	Az/x/y	1100	50	48.8	20	2.405	1500	F17	A																			A	48.41
NNST15	Bz/x/y	1100	50	48.8	20	2.561	1500	-	A																			A	50.68
NNST15	Cz/x/y	1100	50	48.9	20	2.546	1500	-					A					A										A	48.04
NNST17	Az/x/y	1100	75	74.8	20	2.645	1000	F18																				A	80.00
NNST17	Bz/x/y	1100	75	74.4	20	2.621	1000	-	A																			A	74.85
NNST17	Cz/x/y	1100	75	74.4	20	2.647	1000	-																				A	77.82
NNST11	Az/x/y	1100	100	100.0	20	2.558	1000	F19																				A	96.95
NNST11	Bz/x/y	1100	100	99.9	20	2.579	1000	-																				A	102.38
NNST11	Cz/x/y	1100	100	99.9	20	2.532	1000	-																				A	101.31



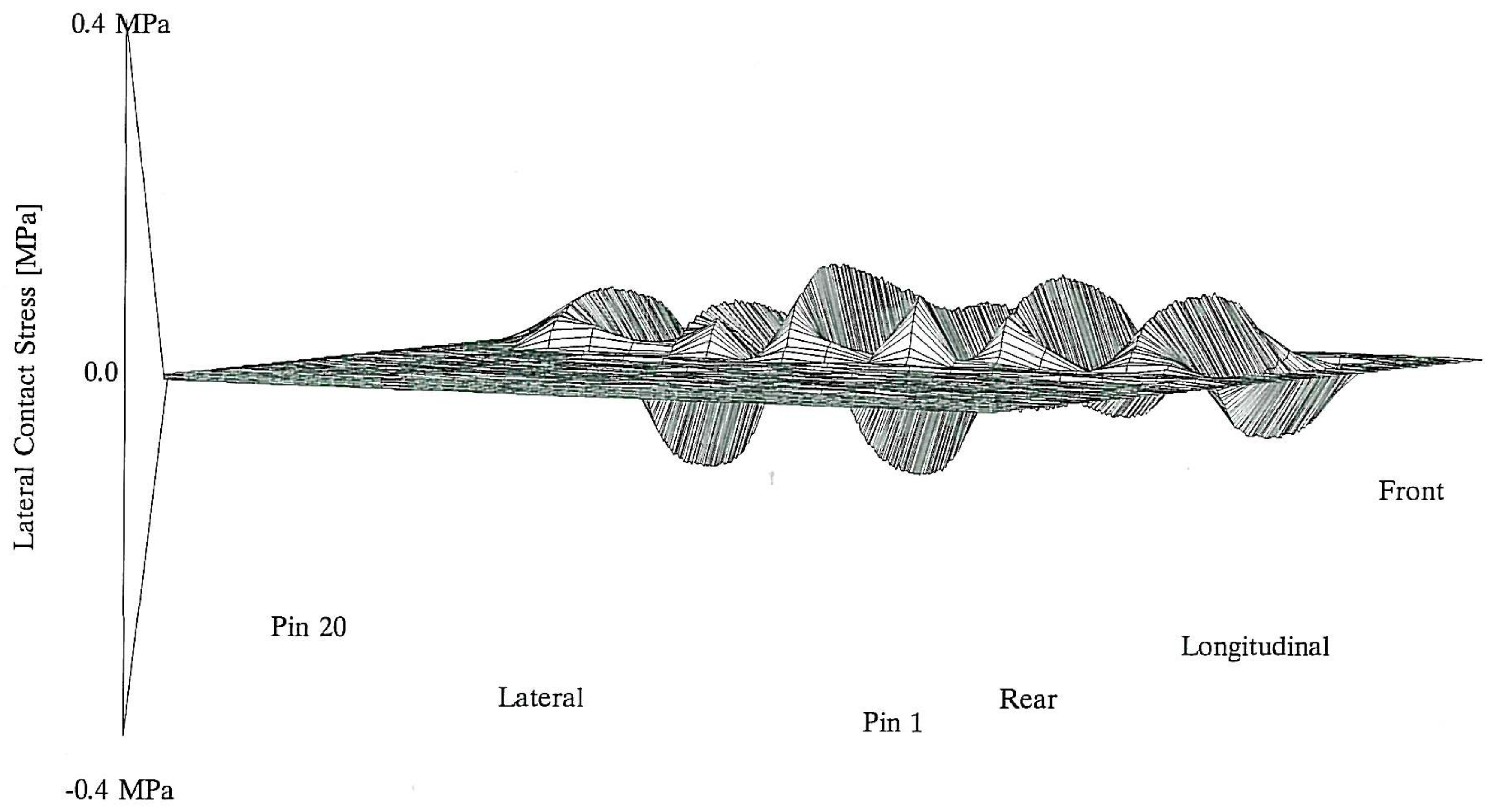
New Bridgestone 425/65R22.5 R164BZ

Filename : nnst52az

FIGURE F1Z

Applied Vertical Load (HVS) = 25 kN
Measured Lateral Load = 0.1734 kN
Max. Stress = 0.1053 MPa
Min. Stress = -0.1357 MPa

Inflation Press. = 500 kPa
Temperature = 20 deg.C
Wheel Speed = 3.222 m/s



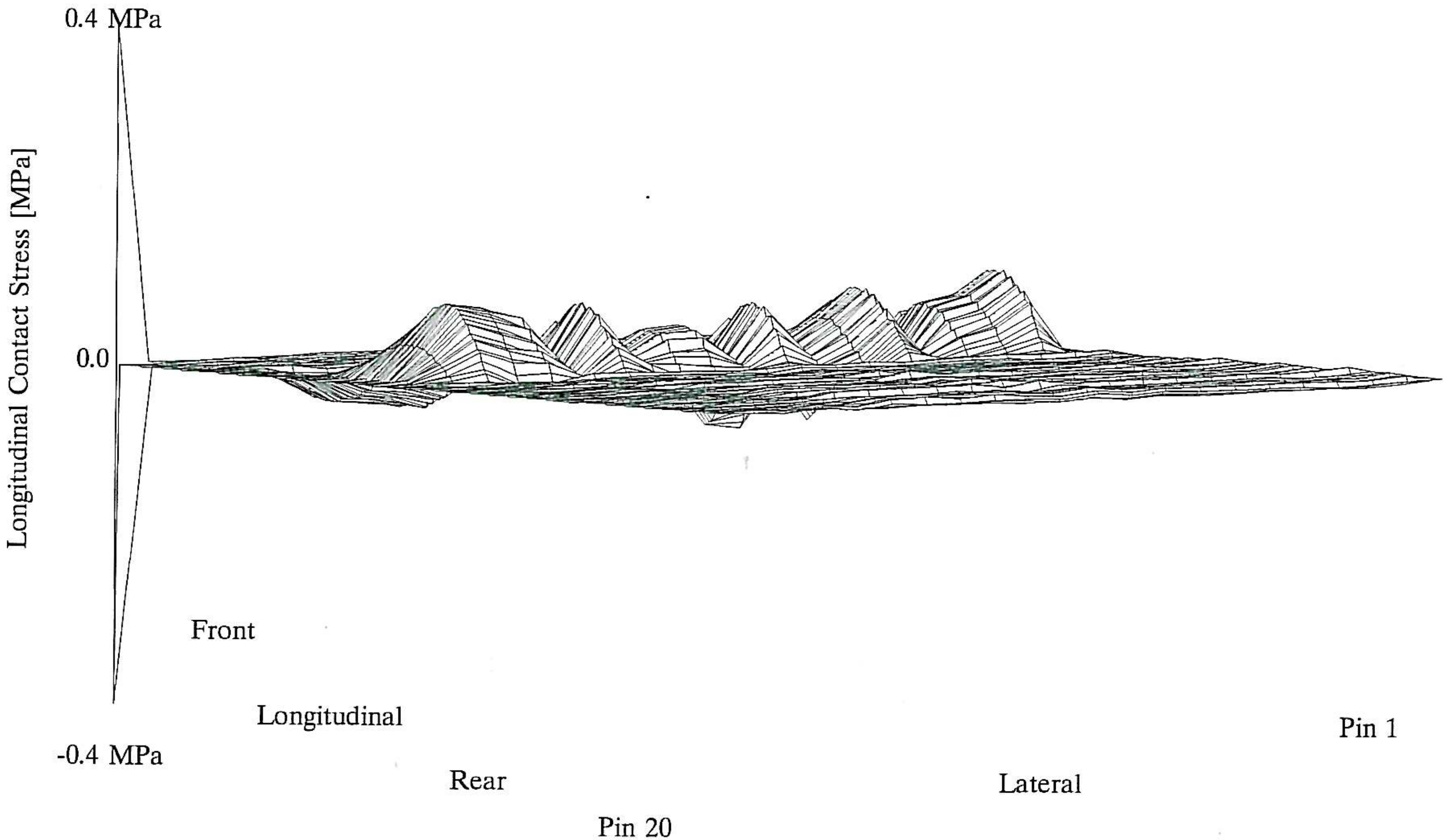
Filename : nnst52ay

New Bridgestone 425/65R22.5 R164BZ

FIGURE F1Y

Applied Vertical Load (HVS) = 25 kN
Measured Longitudinal Load = 0.4746 kN
Max. Stress = 0.09825 MPa
Min. Stress = -0.06689 MPa

Inflation Press. = 500 kPa
Temperature = 20 deg.C
Wheel Speed = 3.222 m/s



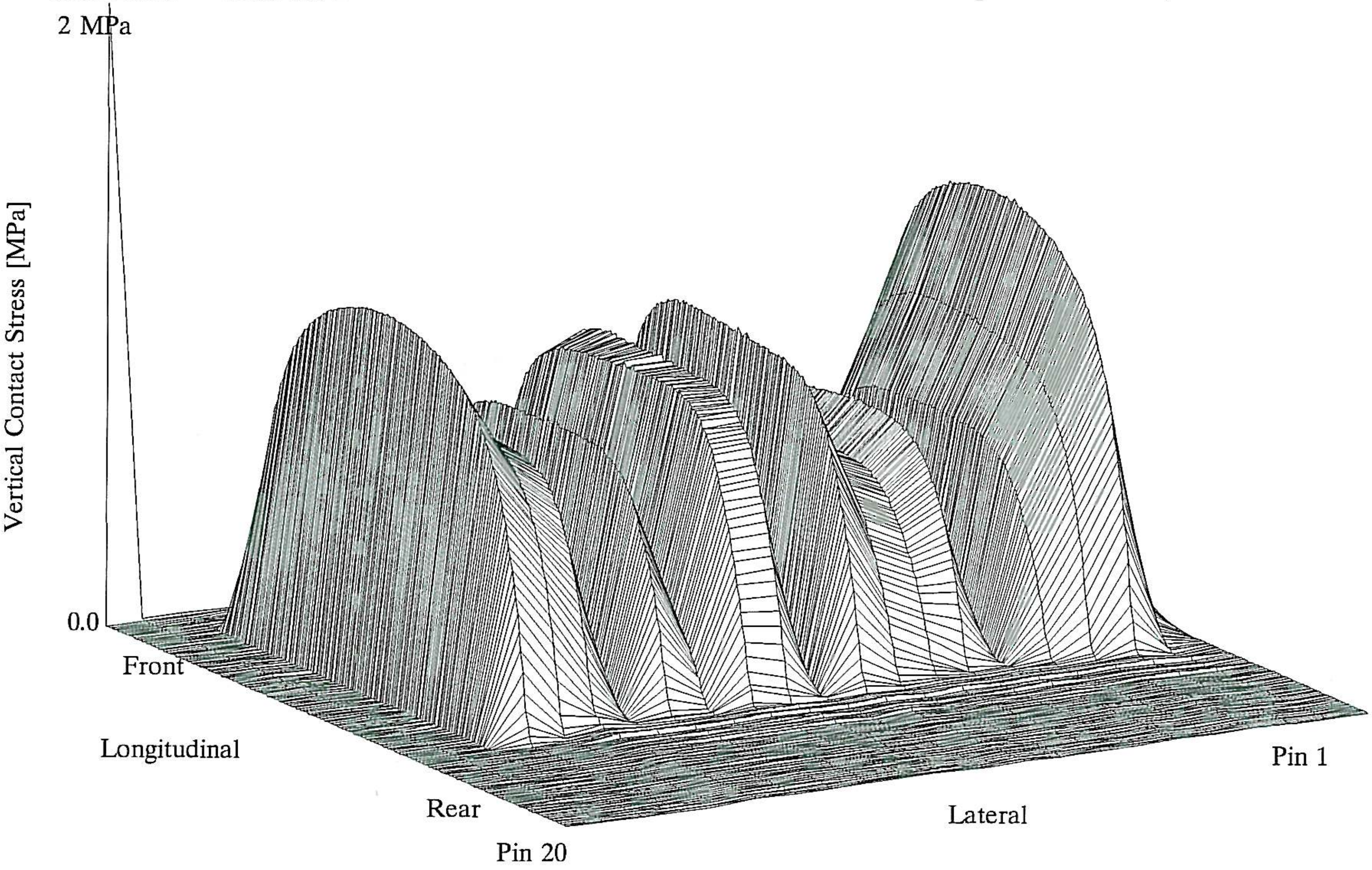
New Bridgestone 425/65R22.5 R164BZ

FIGURE F1X

Filename : nnst52ax

Applied Vertical Load (HVS) = 50 kN
Measured Vertical Load = 50.89 kN
Max. Stress = 1.301 MPa

Inflation Press. = 500 kPa
Temperature = 20 deg.C
Wheel Speed = 3.131 m/s



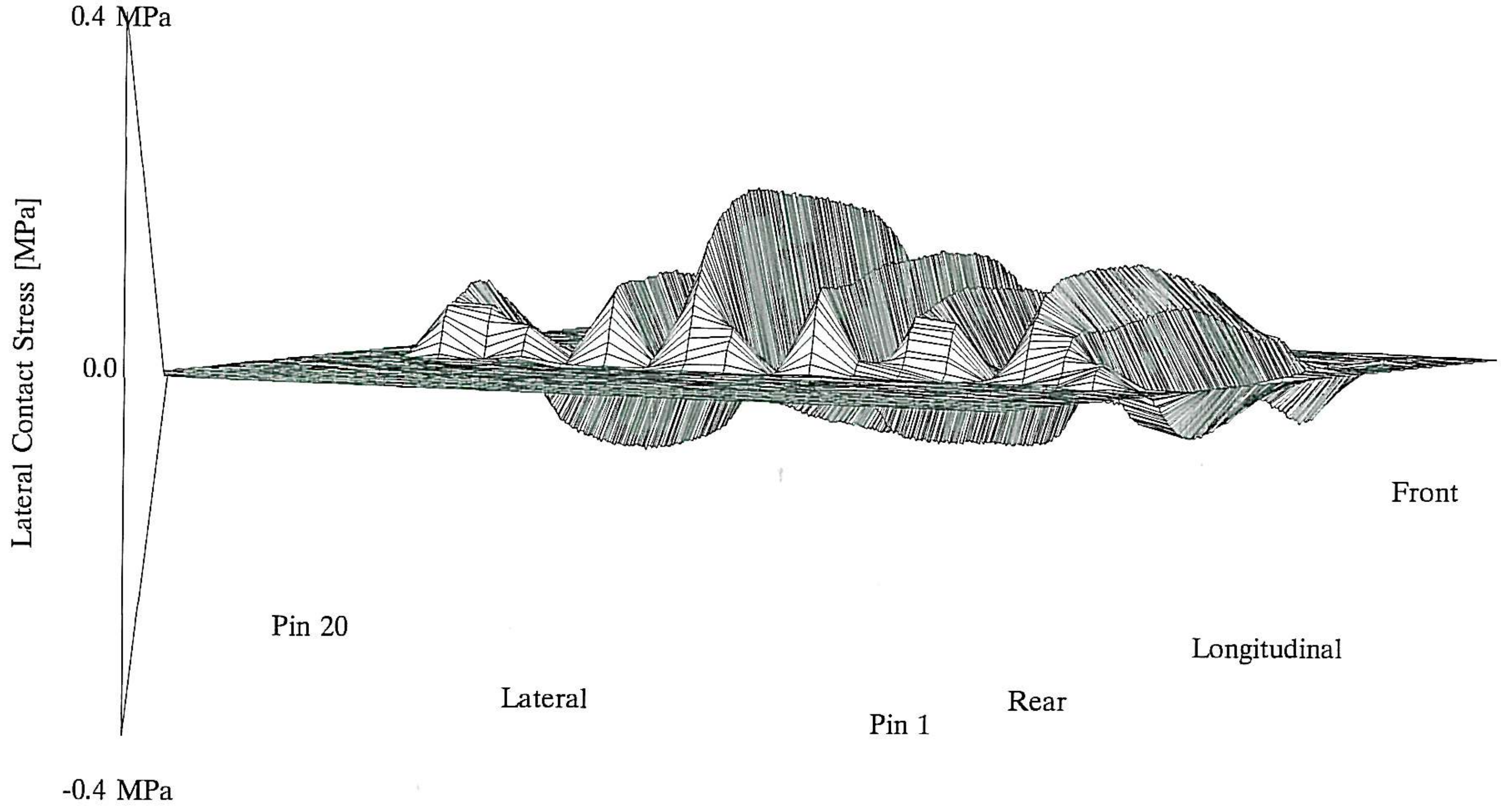
New Bridgestone 425/65R22.5 R164BZ

Filename : nnst55az

FIGURE F2Z

Applied Vertical Load (HVS) = 50 kN
Measured Lateral Load = 1.552 kN
Max. Stress = 0.1954 MPa
Min. Stress = -0.1095 MPa

Inflation Press. = 500 kPa
Temperature = 20 deg.C
Wheel Speed = 3.131 m/s



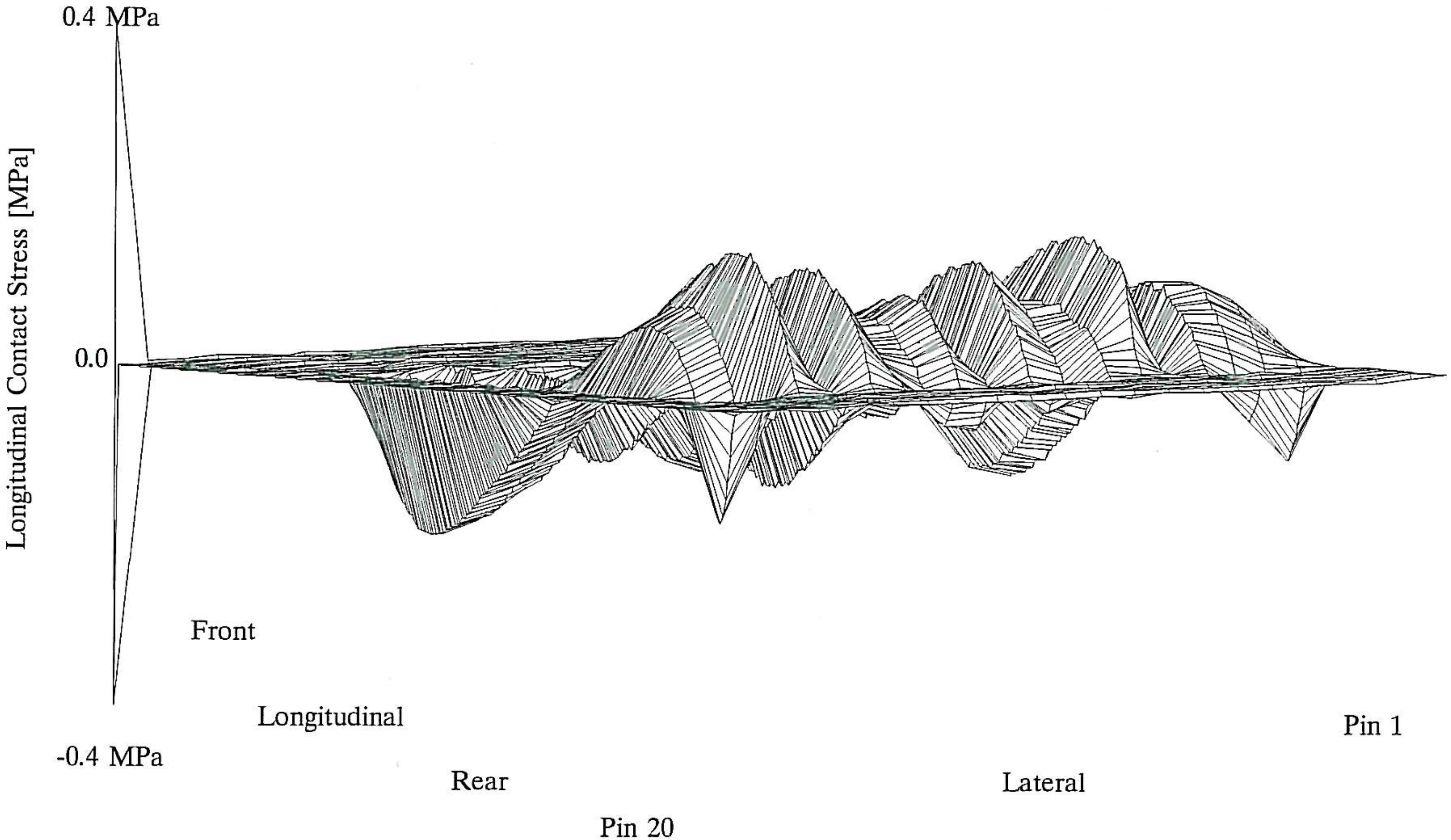
Filename : nnst55ay

New Bridgestone 425/65R22.5 R164BZ

FIGURE F2Y

Applied Vertical Load (HVS) = 50 kN
Measured Longitudinal Load = -0.04803 kN
Max. Stress = 0.1636 MPa
Min. Stress = -0.1868 MPa

Inflation Press. = 500 kPa
Temperature = 20 deg.C
Wheel Speed = 3.131 m/s



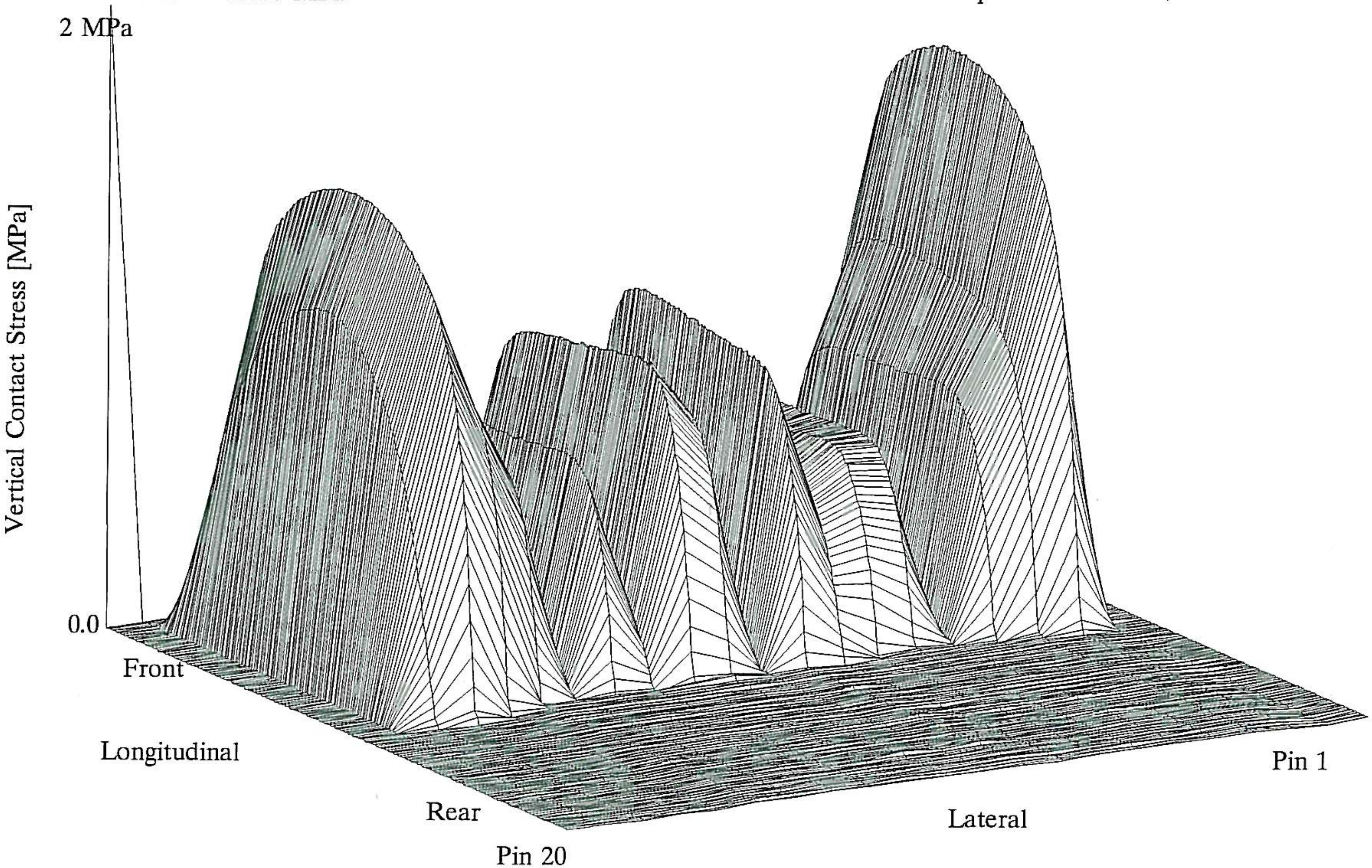
New Bridgestone 425/65R22.5 R164BZ

Filename : nnst55ax

FIGURE F2X

Applied Vertical Load (HVS) = 75 kN
Measured Vertical Load = 76.34 kN
Max. Stress = 1.707 MPa

Inflation Press. = 500 kPa
Temperature = 21 deg.C
Wheel Speed = 3.059 m/s



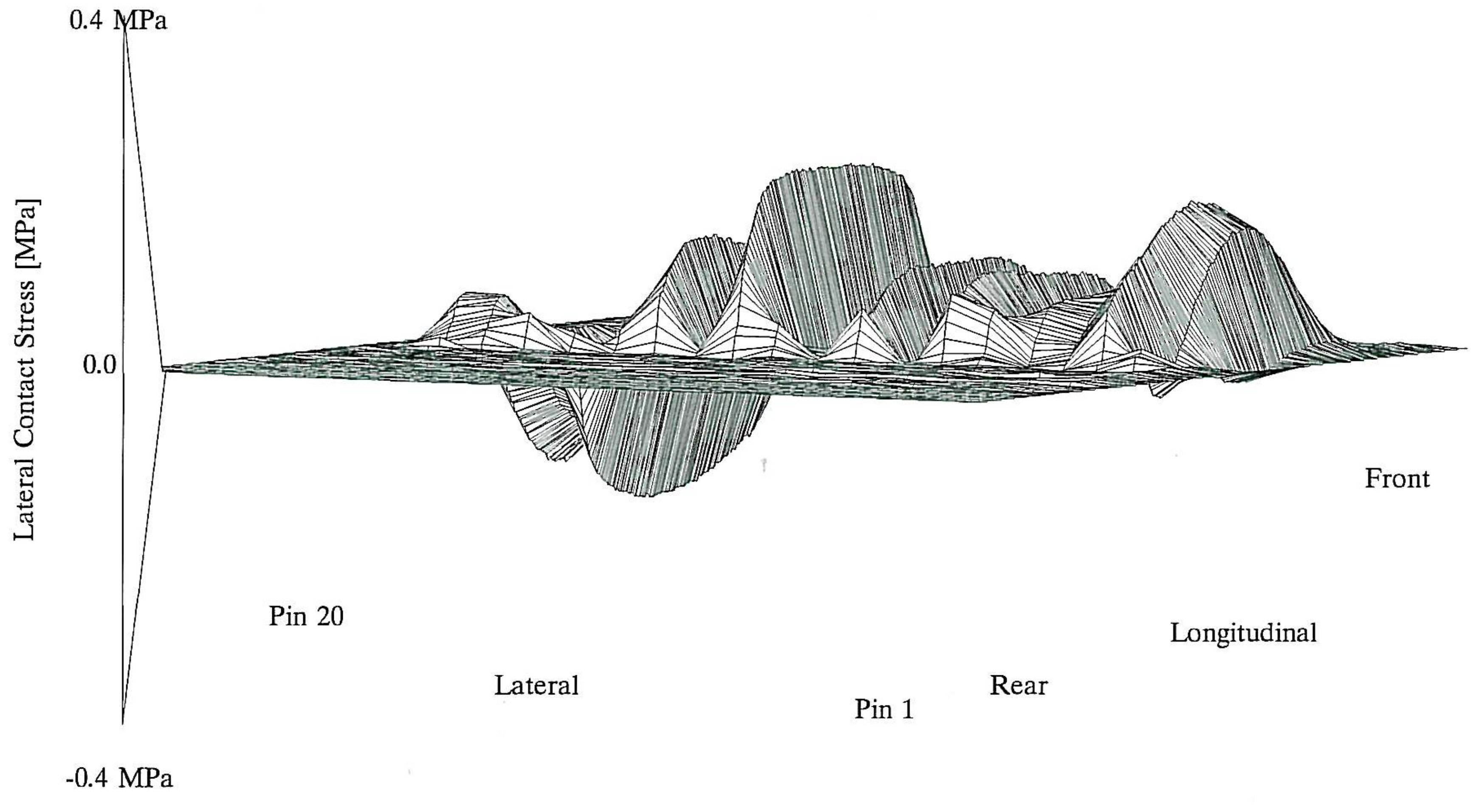
New Bridgestone 425/65R22.5 R164BZ

FIGURE F3Z

Filename : nnst57az

Applied Vertical Load (HVS) = 75 kN
Measured Lateral Load = 2.644 kN
Max. Stress = 0.2051 MPa
Min. Stress = -0.1746 MPa

Inflation Press. = 500 kPa
Temperature = 21 deg.C
Wheel Speed = 3.059 m/s



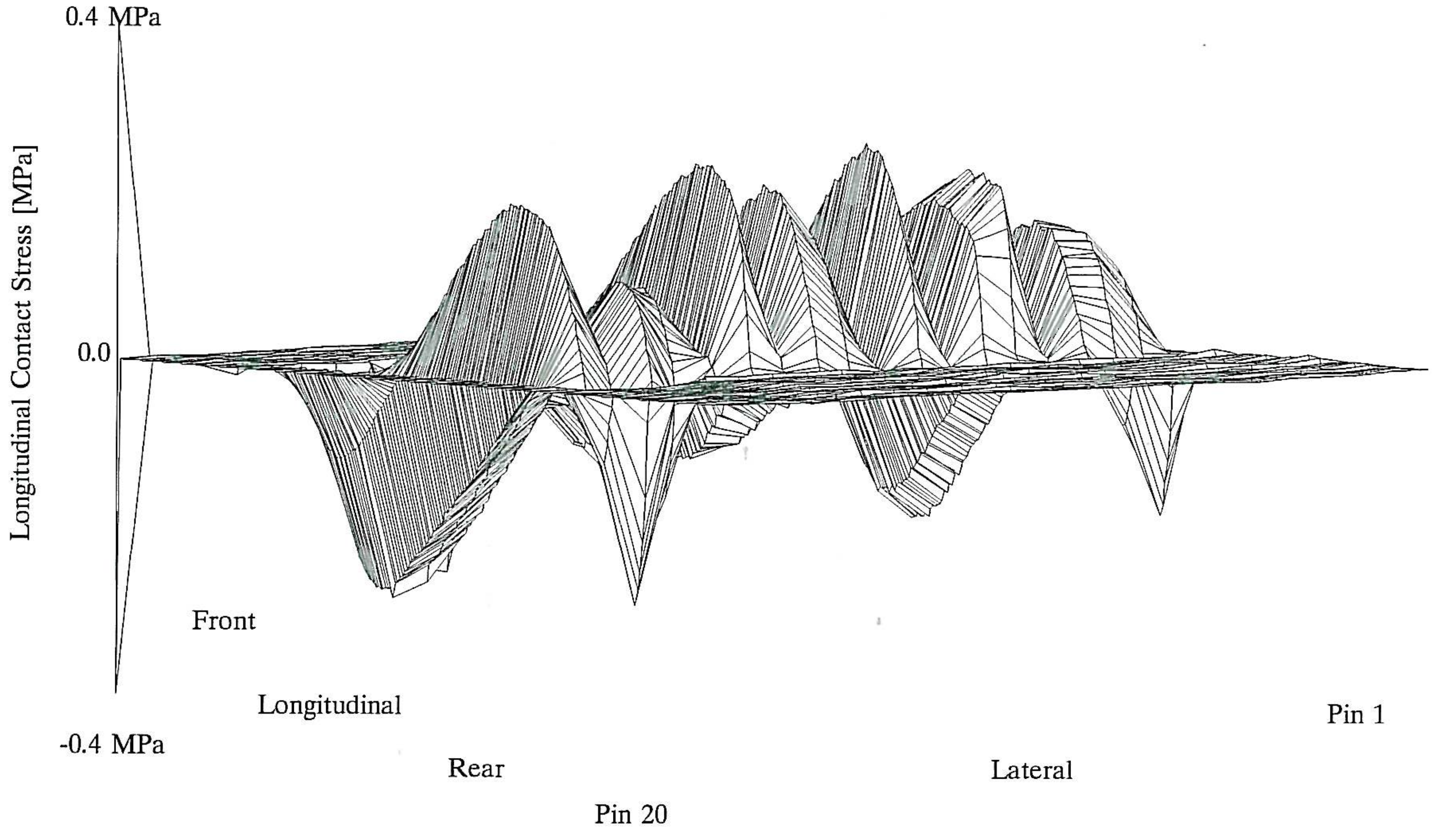
New Bridgestone 425/65R22.5 R164BZ

FIGURE F3Y

Filename : nnst57ay

Applied Vertical Load (HVS) = 75 kN
Measured Longitudinal Load = 1.388 kN
Max. Stress = 0.2644 MPa
Min. Stress = -0.2764 MPa

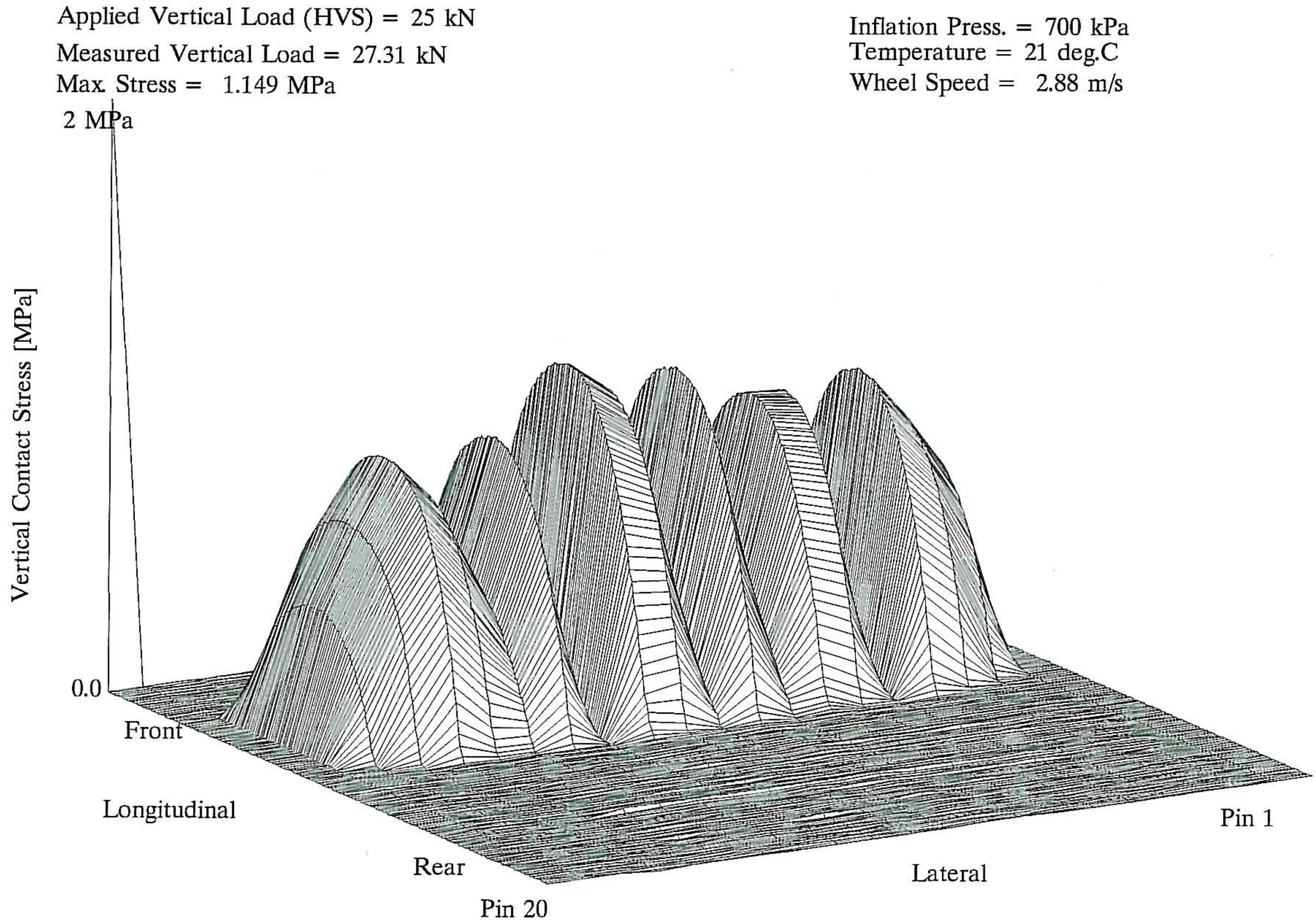
Inflation Press. = 500 kPa
Temperature = 21 deg.C
Wheel Speed = 3.059 m/s



New Bridgestone 425/65R22.5 R164BZ

Filename : nnst57ax

FIGURE F3X



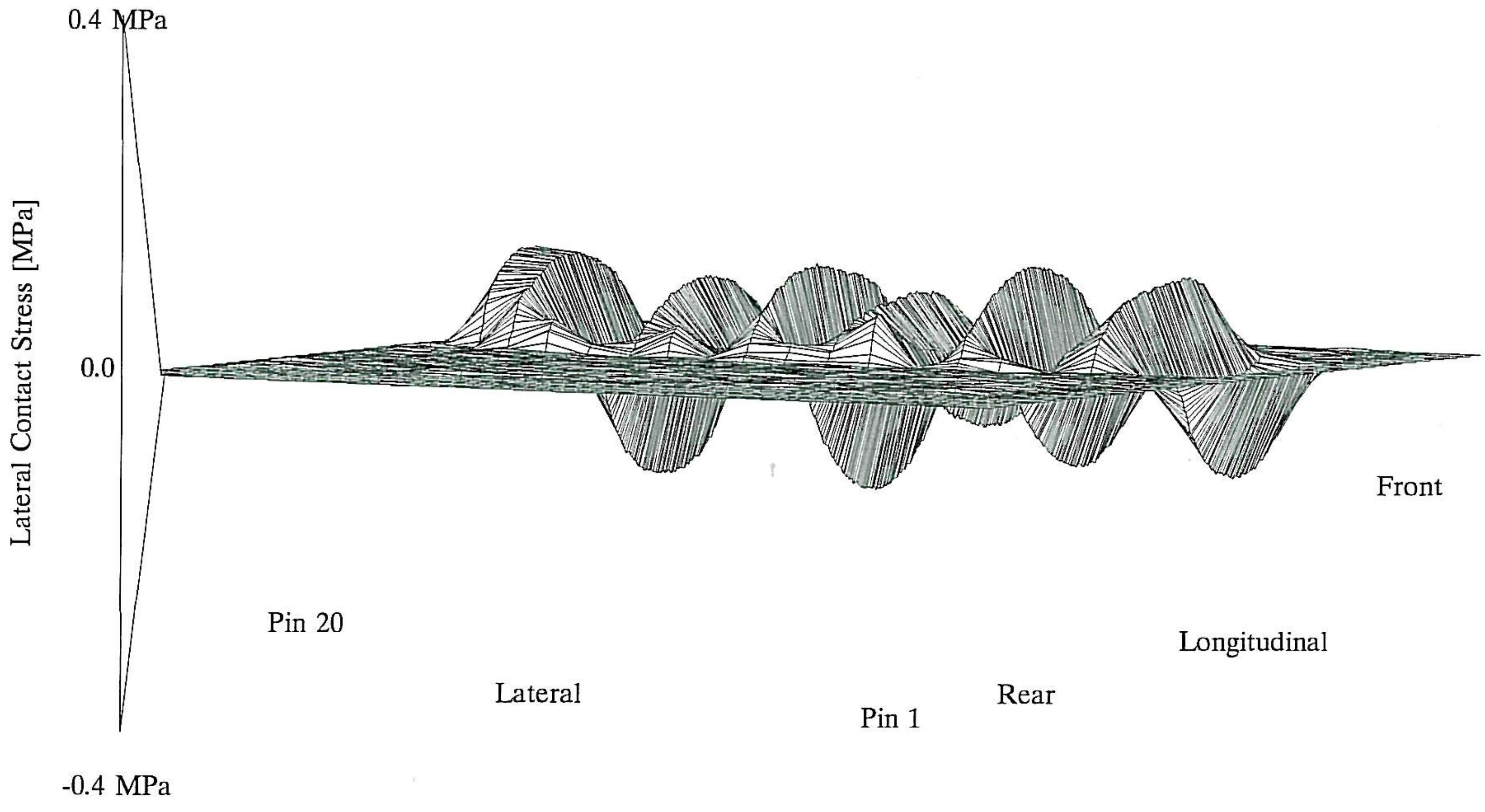
New Bridgestone 425/65R22.5 R164BZ

Filename : nnst72az

FIGURE F4Z

Applied Vertical Load (HVS) = 25 kN
Measured Lateral Load = 0.1304 kN
Max. Stress = 0.108 MPa
Min. Stress = -0.1518 MPa

Inflation Press. = 700 kPa
Temperature = 21 deg.C
Wheel Speed = 2.88 m/s



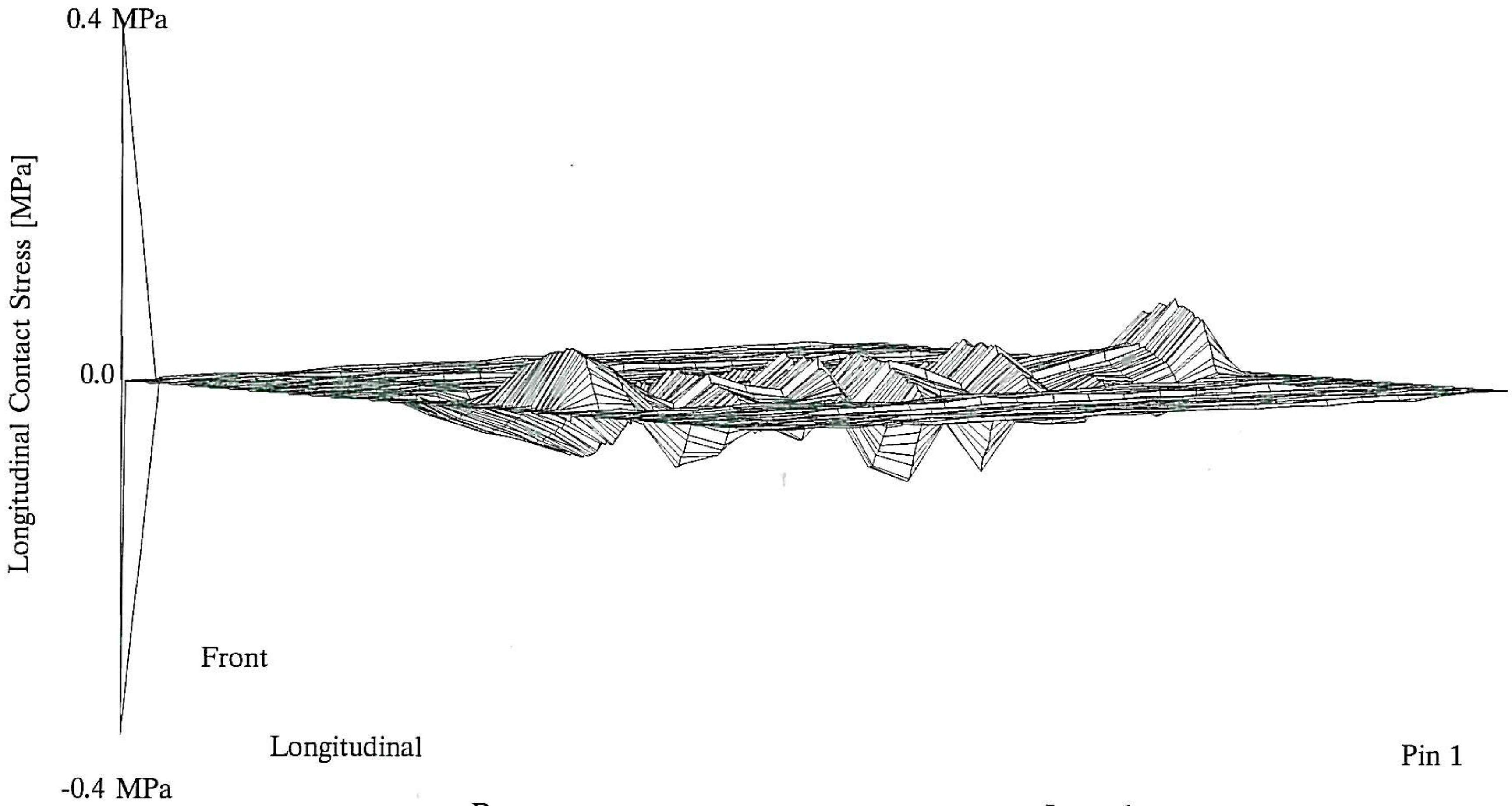
Filename : nnst72ay

New Bridgestone 425/65R22.5 R164BZ

FIGURE F4Y

Applied Vertical Load (HVS) = 25 kN
Measured Longitudinal Load = -0.4654 kN
Max. Stress = 0.08698 MPa
Min. Stress = -0.09765 MPa

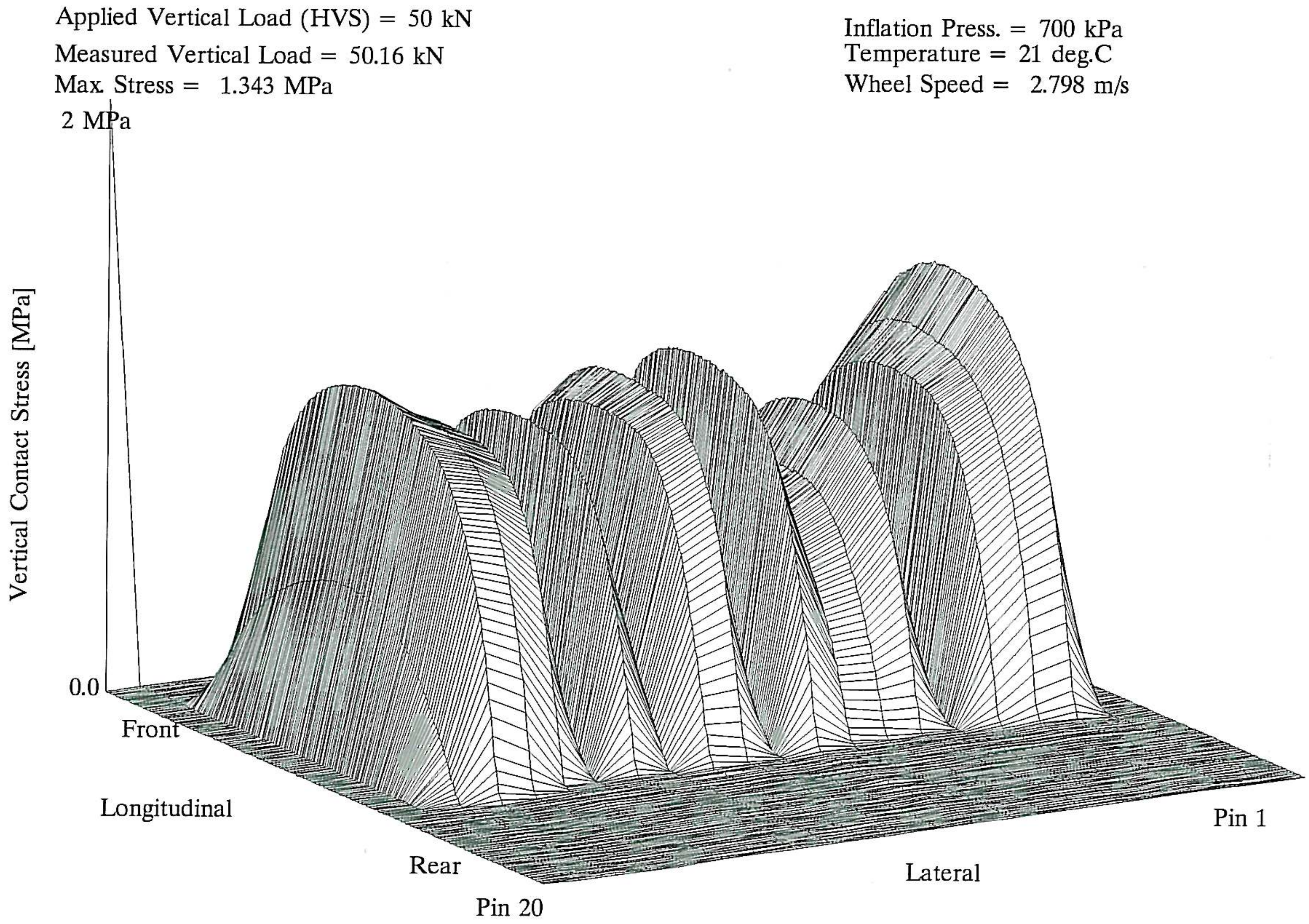
Inflation Press. = 700 kPa
Temperature = 21 deg.C
Wheel Speed = 2.88 m/s



New Bridgestone 425/65R22.5 R164BZ

FIGURE F4X

Filename : nnst72ax



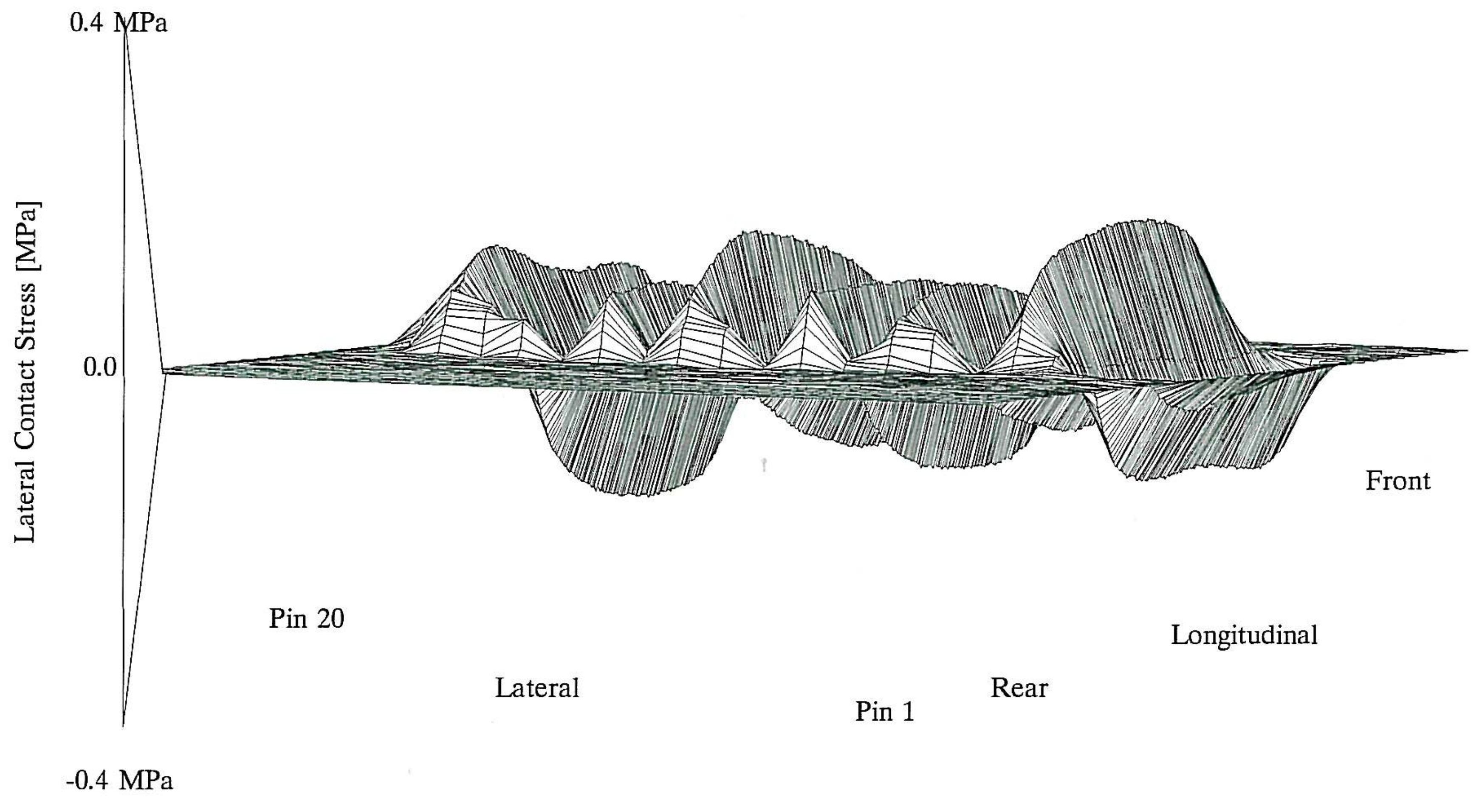
New Bridgestone 425/65R22.5 R164BZ

Filename : nnst75az

FIGURE F5Z

Applied Vertical Load (HVS) = 50 kN
Measured Lateral Load = 0.3898 kN
Max. Stress = 0.1615 MPa
Min. Stress = -0.1716 MPa

Inflation Press. = 700 kPa
Temperature = 21 deg.C
Wheel Speed = 2.798 m/s



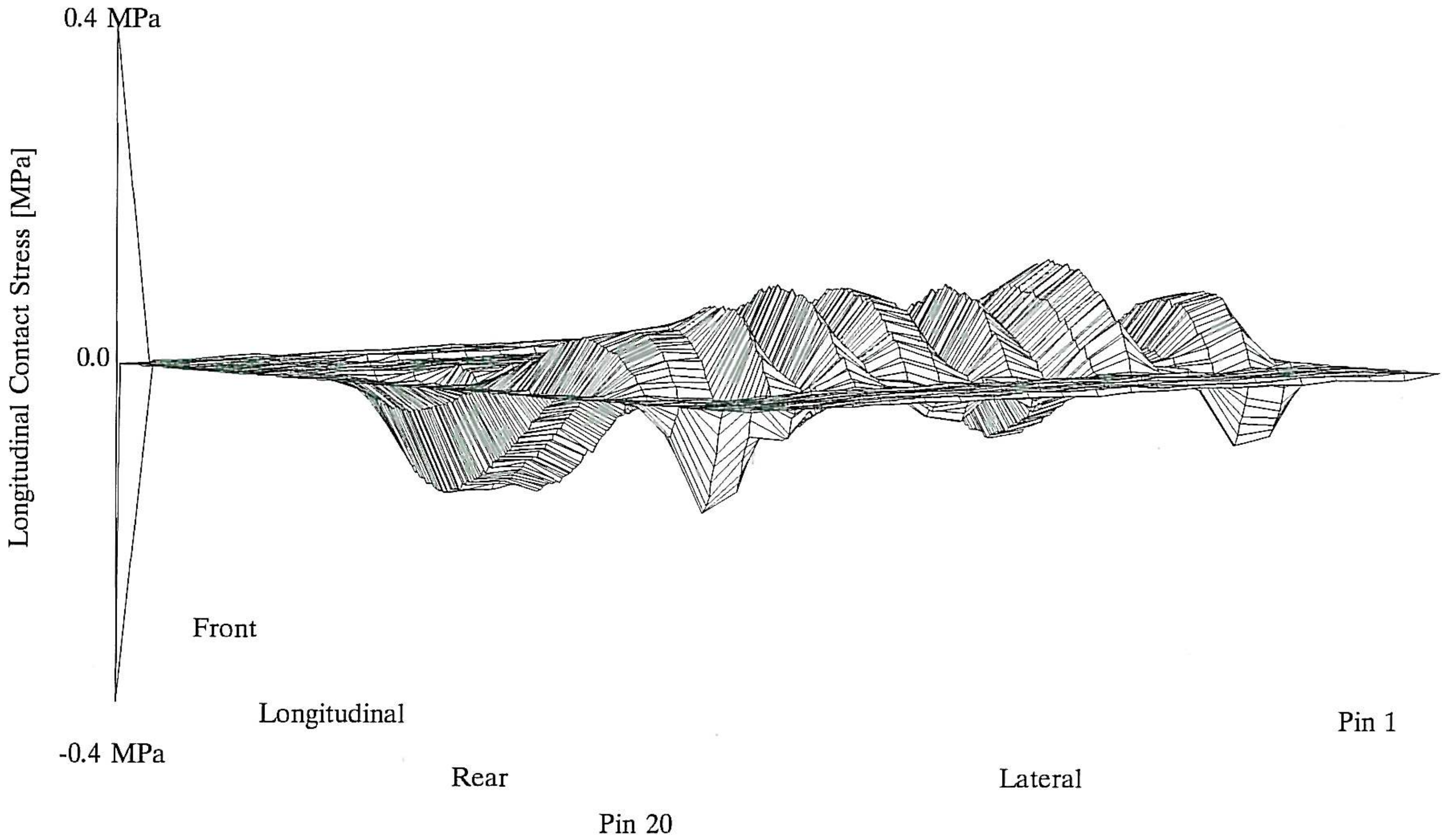
New Bridgestone 425/65R22.5 R164BZ

FIGURE F5Y

Filename : nnst75ay

Applied Vertical Load (HVS) = 50 kN
Measured Longitudinal Load = 0.2564 kN
Max. Stress = 0.1311 MPa
Min. Stress = -0.1391 MPa

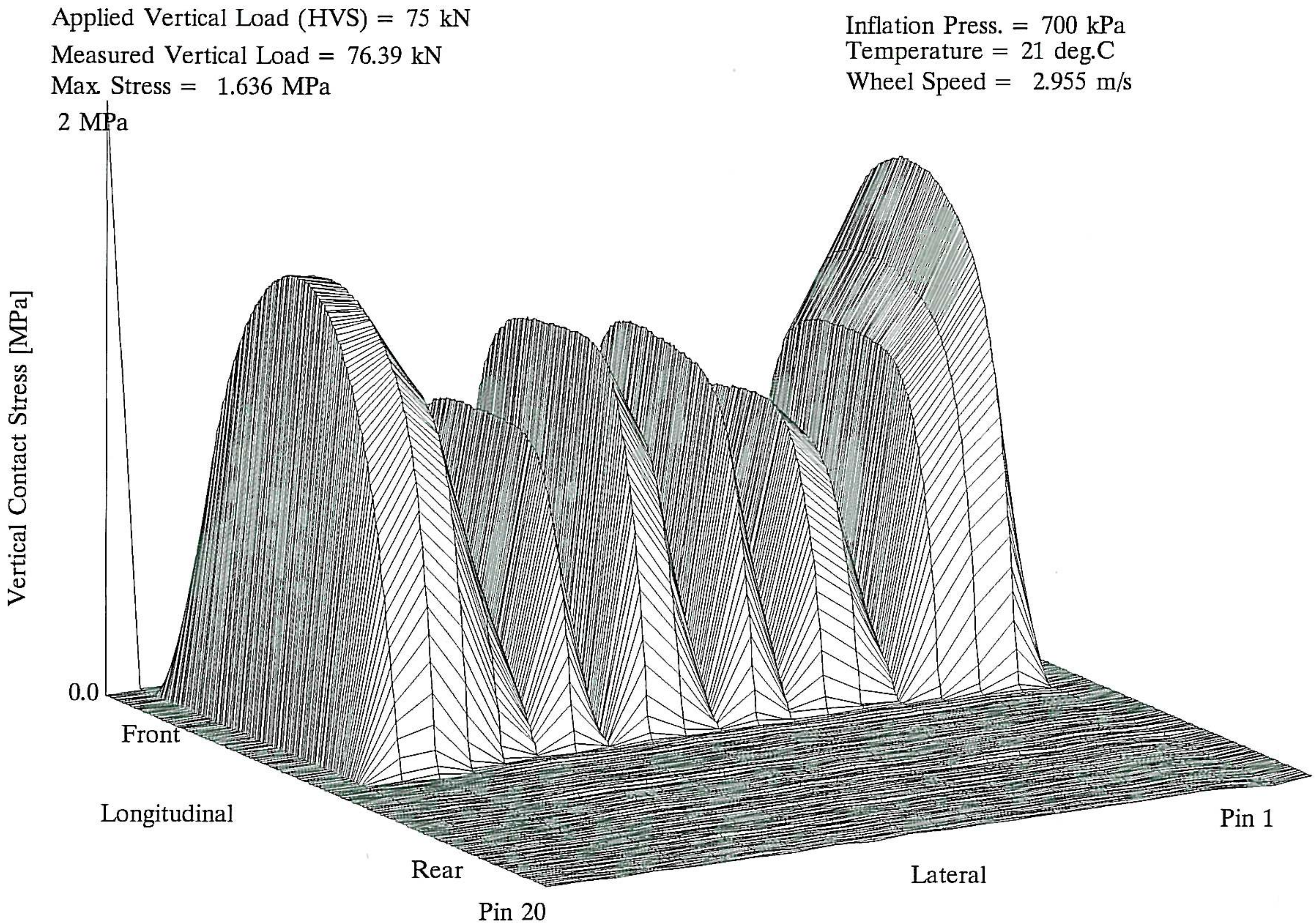
Inflation Press. = 700 kPa
Temperature = 21 deg.C
Wheel Speed = 2.798 m/s



New Bridgestone 425/65R22.5 R164BZ

Filename : nnst75ax

FIGURE F5X



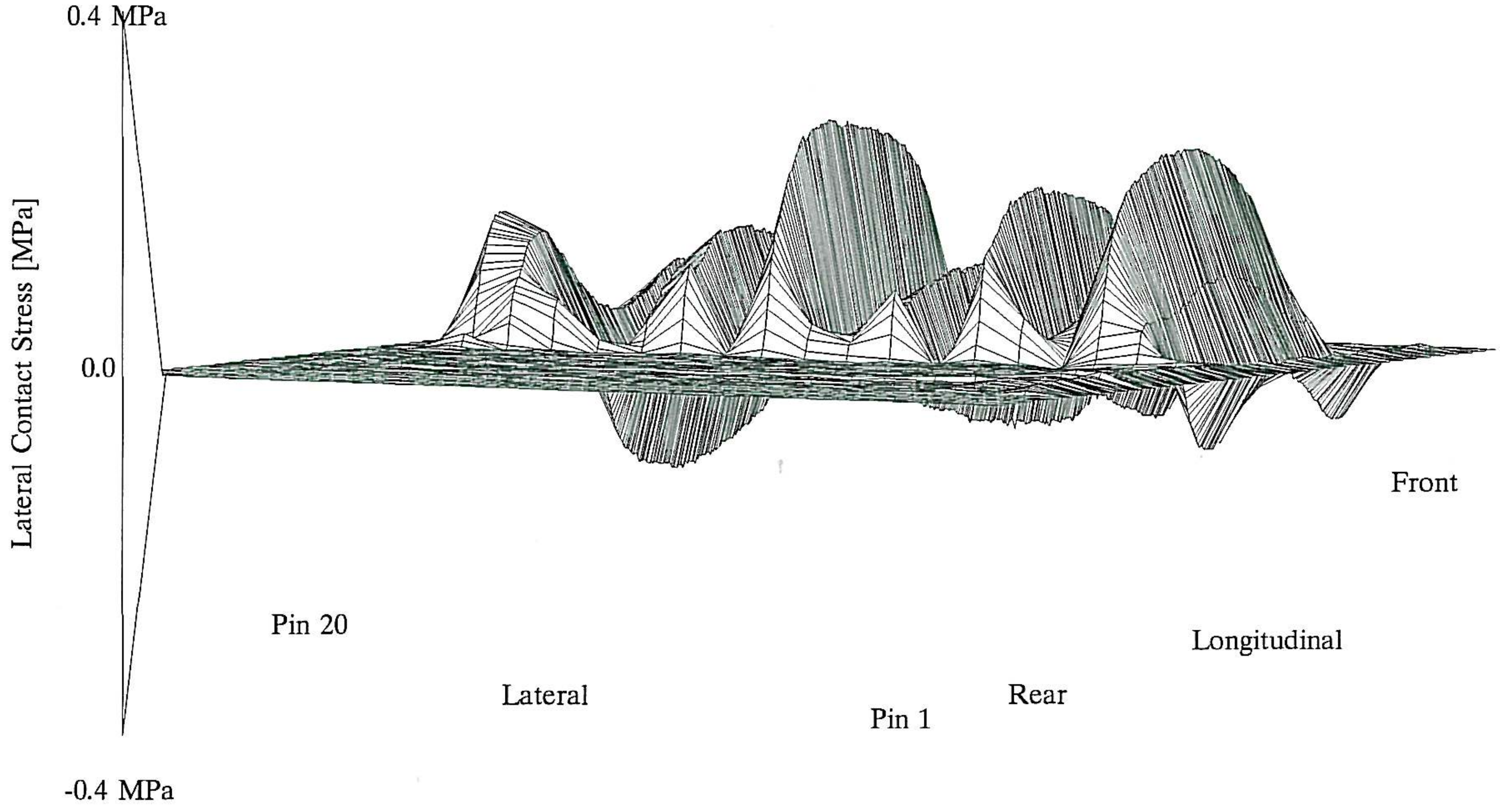
New Bridgestone 425/65R22.5 R164BZ

FIGURE F6Z

Filename : nnst77az

Applied Vertical Load (HVS) = 75 kN
Measured Lateral Load = 4.322 kN
Max. Stress = 0.2549 MPa
Min. Stress = -0.1376 MPa

Inflation Press. = 700 kPa
Temperature = 21 deg.C
Wheel Speed = 2.955 m/s



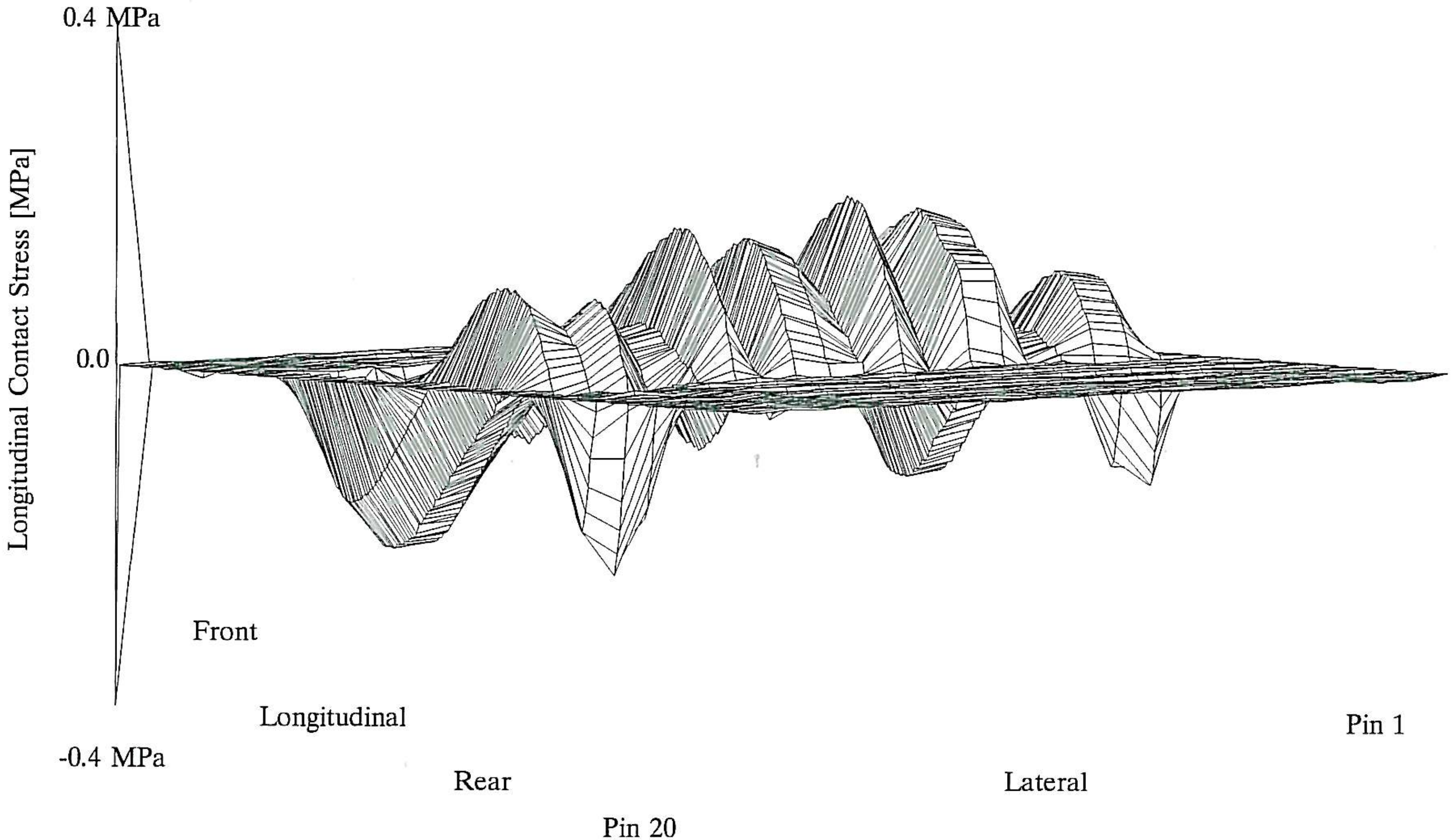
Filename : nnst77ay

New Bridgestone 425/65R22.5 R164BZ

FIGURE F6Y

Applied Vertical Load (HVS) = 75 kN
Measured Longitudinal Load = 0.3302 kN
Max. Stress = 0.202 MPa
Min. Stress = -0.2192 MPa

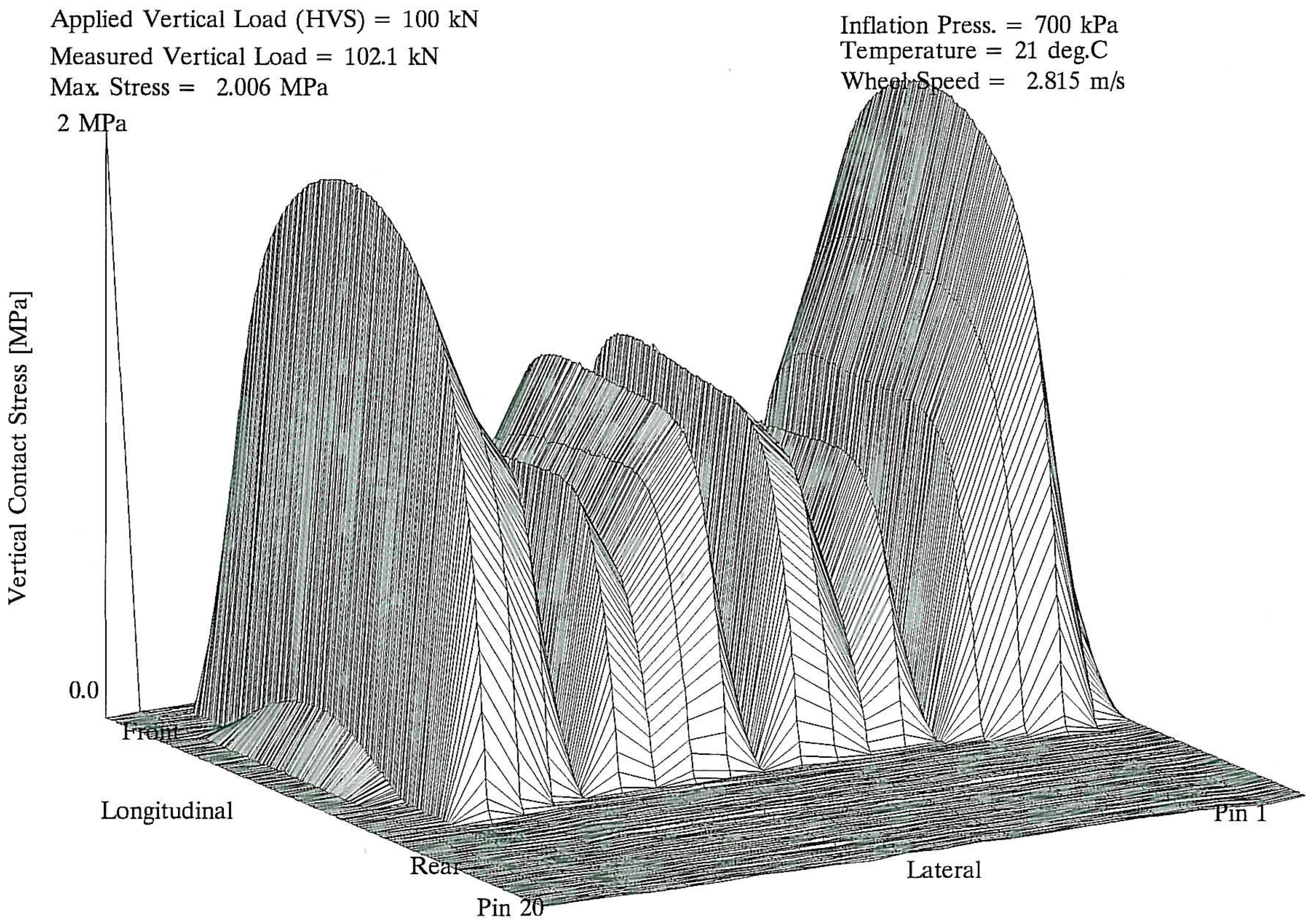
Inflation Press. = 700 kPa
Temperature = 21 deg.C
Wheel Speed = 2.955 m/s



Filename : nnst77ax

New Bridgestone 425/65R22.5 R164BZ

FIGURE F6X



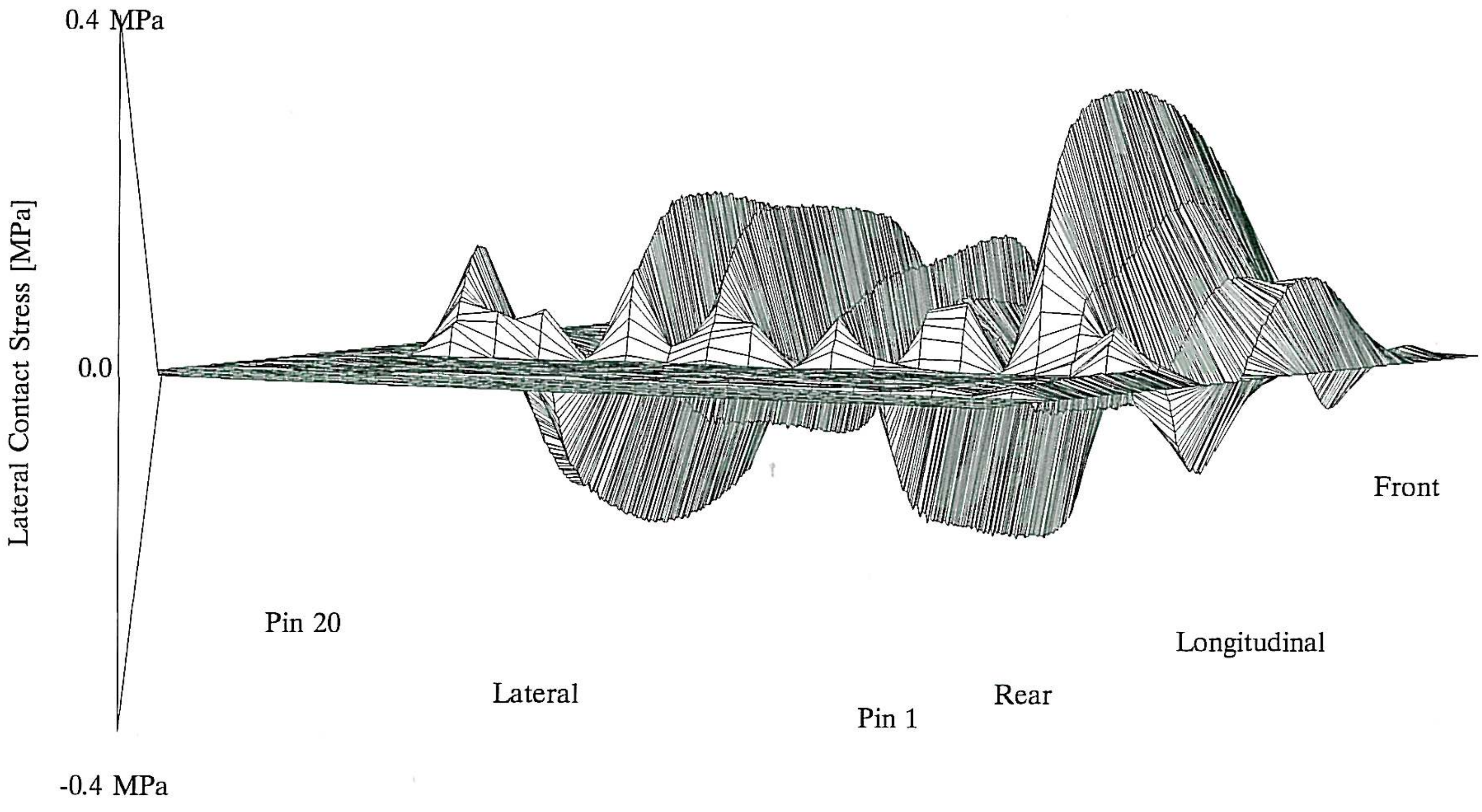
New Bridgestone 425/65R22.5 R164BZ

FIGURE F7Z

Filename : nnst71az

Applied Vertical Load (HVS) = 100 kN
Measured Lateral Load = 1.742 kN
Max. Stress = 0.3123 MPa
Min. Stress = -0.206 MPa

Inflation Press. = 700 kPa
Temperature = 21 deg.C
Wheel Speed = 2.815 m/s



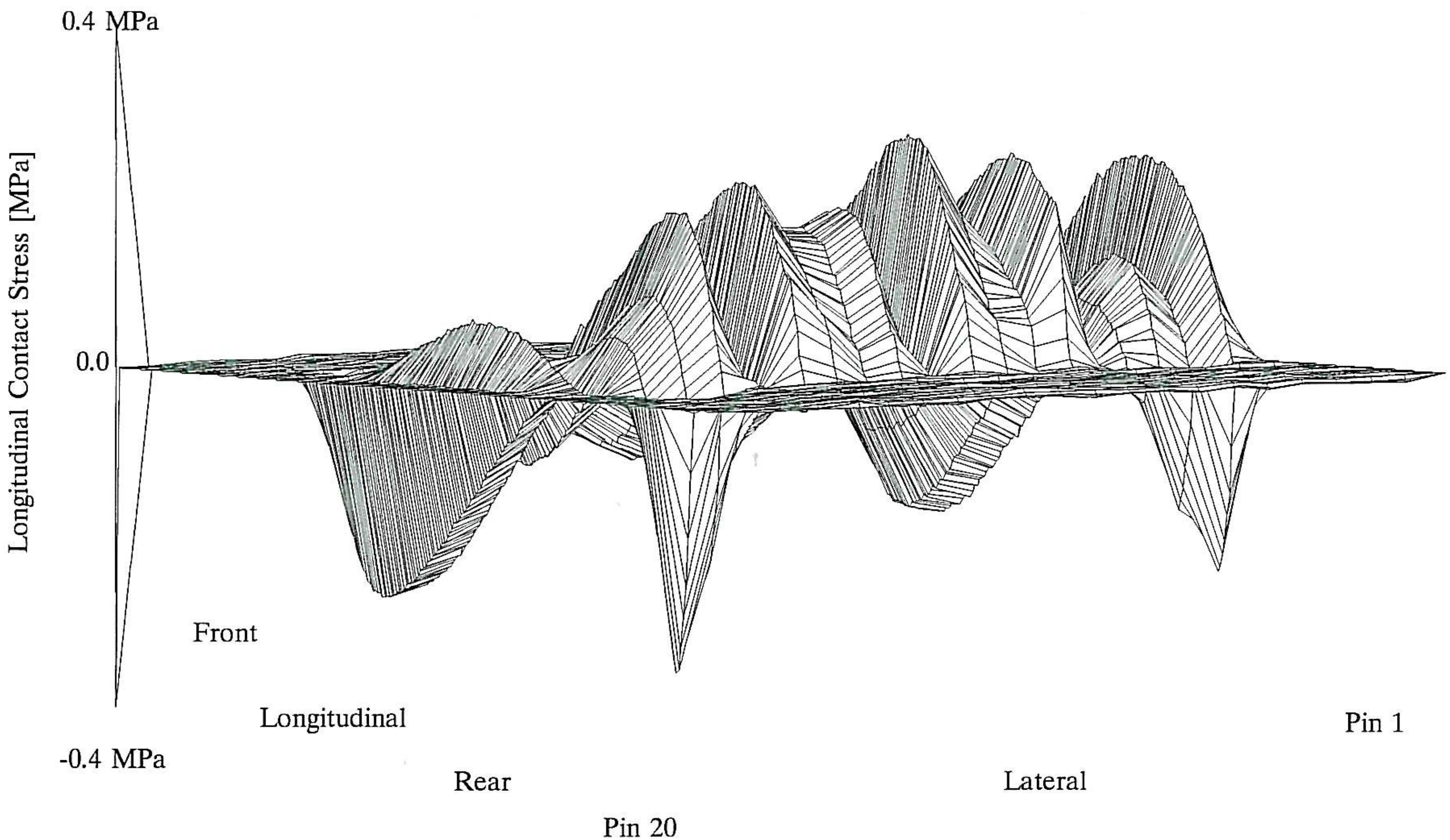
Filename : nnst71ay

New Bridgestone 425/65R22.5 R164BZ

FIGURE F7Y

Applied Vertical Load (HVS) = 100 kN
Measured Longitudinal Load = 1.909 kN
Max. Stress = 0.2827 MPa
Min. Stress = -0.3263 MPa

Inflation Press. = 700 kPa
Temperature = 21 deg.C
Wheel Speed = 2.815 m/s



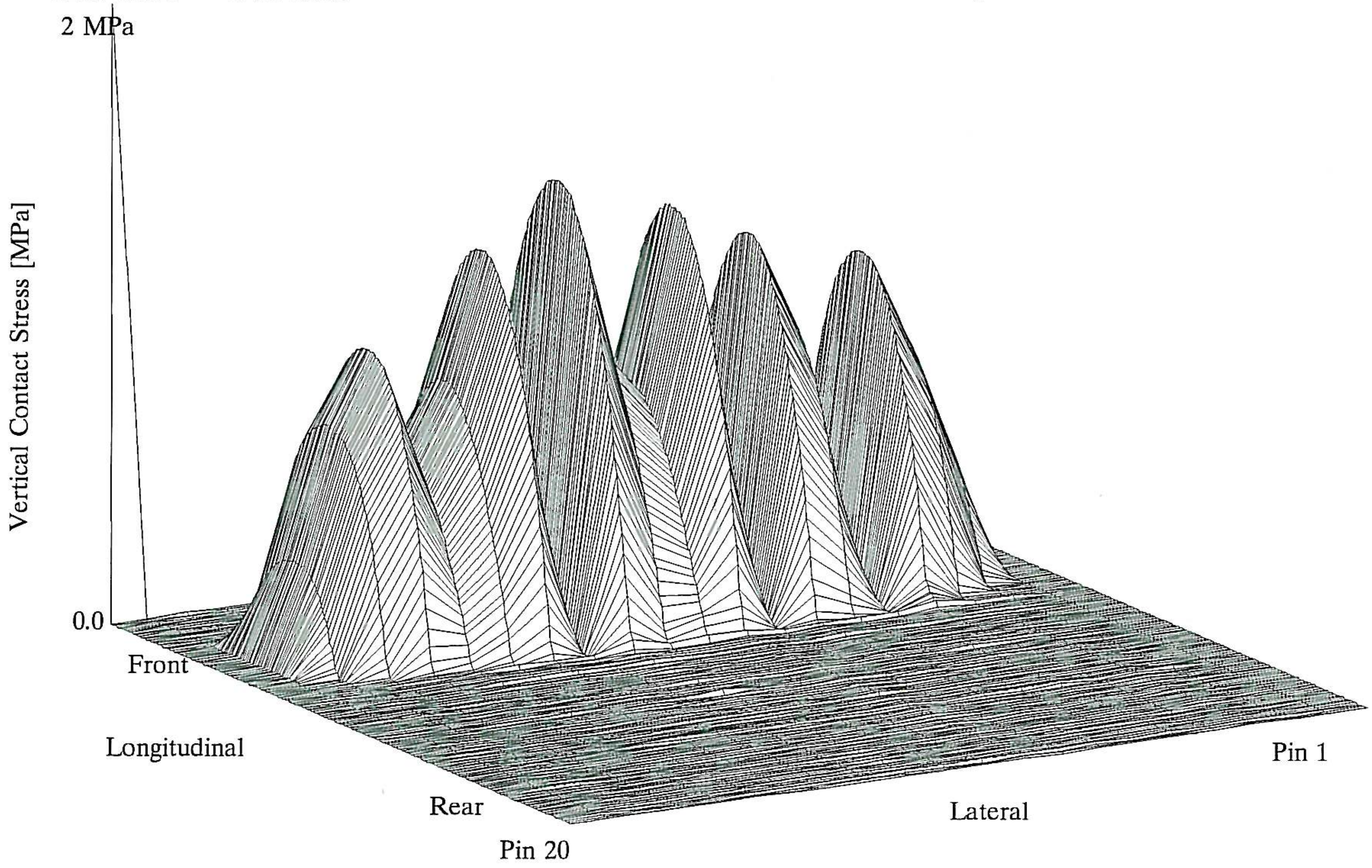
New Bridgestone 425/65R22.5 R164BZ

Filename : nnst71ax

FIGURE F7X

Applied Vertical Load (HVS) = 25 kN
Measured Vertical Load = 25.83 kN
Max. Stress = 1.423 MPa

Inflation Press. = 900 kPa
Temperature = 21 deg.C
Wheel Speed = 3.347 m/s



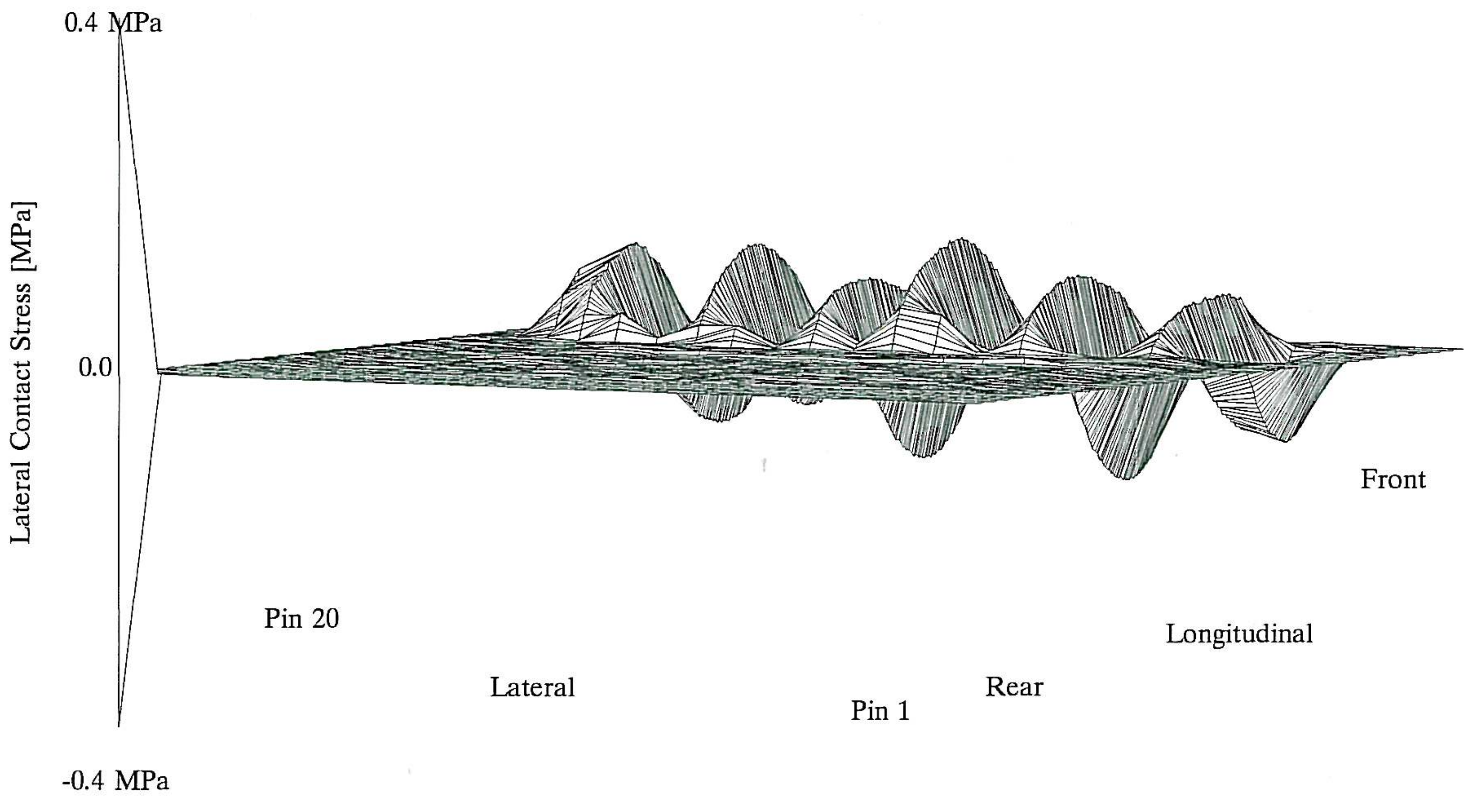
New Bridgestone 425/65R22.5 R164BZ

Filename : nnt902az

FIGURE F8Z

Applied Vertical Load (HVS) = 25 kN
Measured Lateral Load = 0.06967 kN
Max. Stress = 0.1229 MPa
Min. Stress = -0.1461 MPa

Inflation Press. = 900 kPa
Temperature = 21 deg.C
Wheel Speed = 3.347 m/s



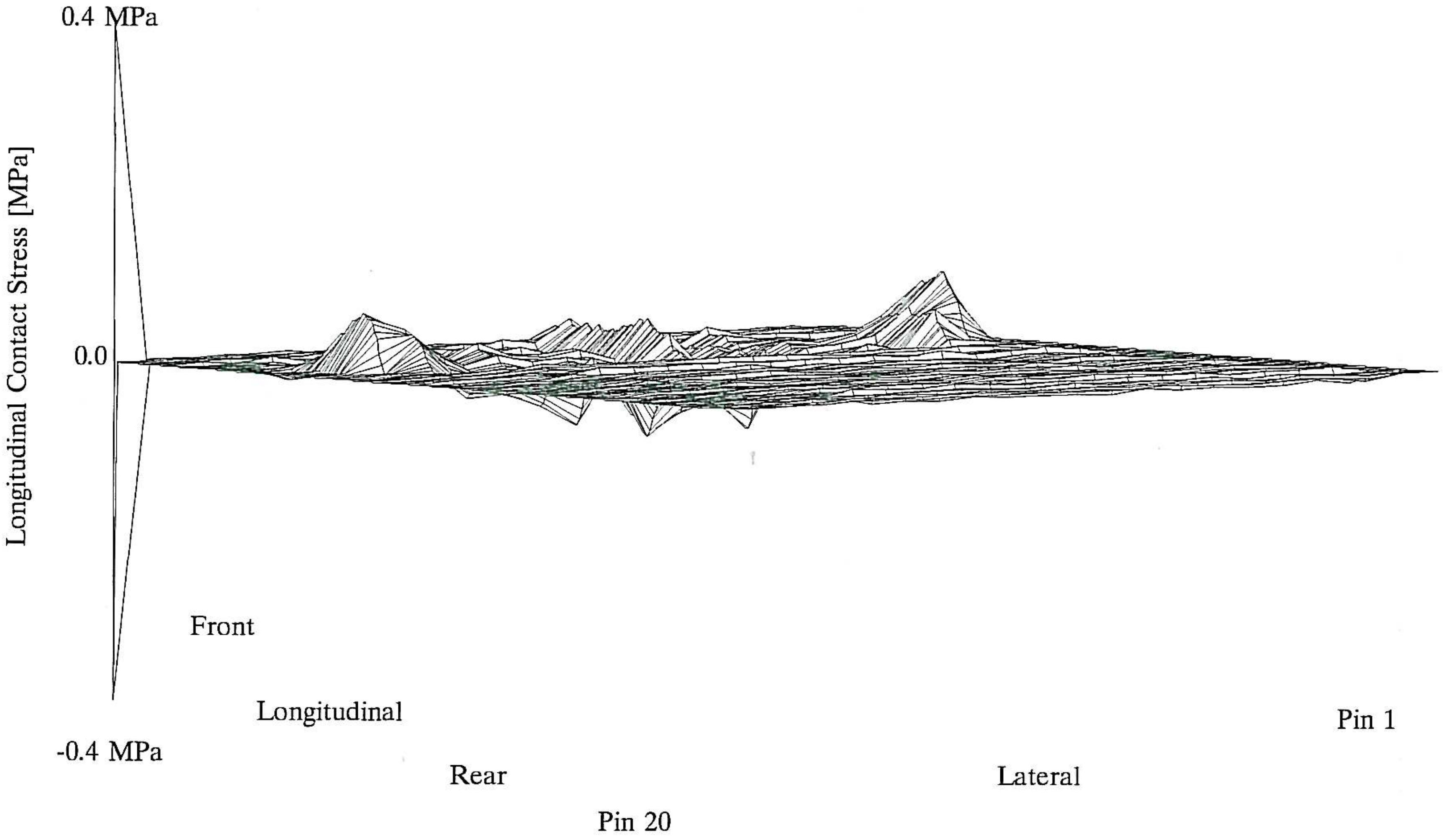
Filename : nnt902ay

New Bridgestone 425/65R22.5 R164BZ

FIGURE F8Y

Applied Vertical Load (HVS) = 25 kN
Measured Longitudinal Load = -0.08801 kN
Max. Stress = 0.08475 MPa
Min. Stress = -0.0869 MPa

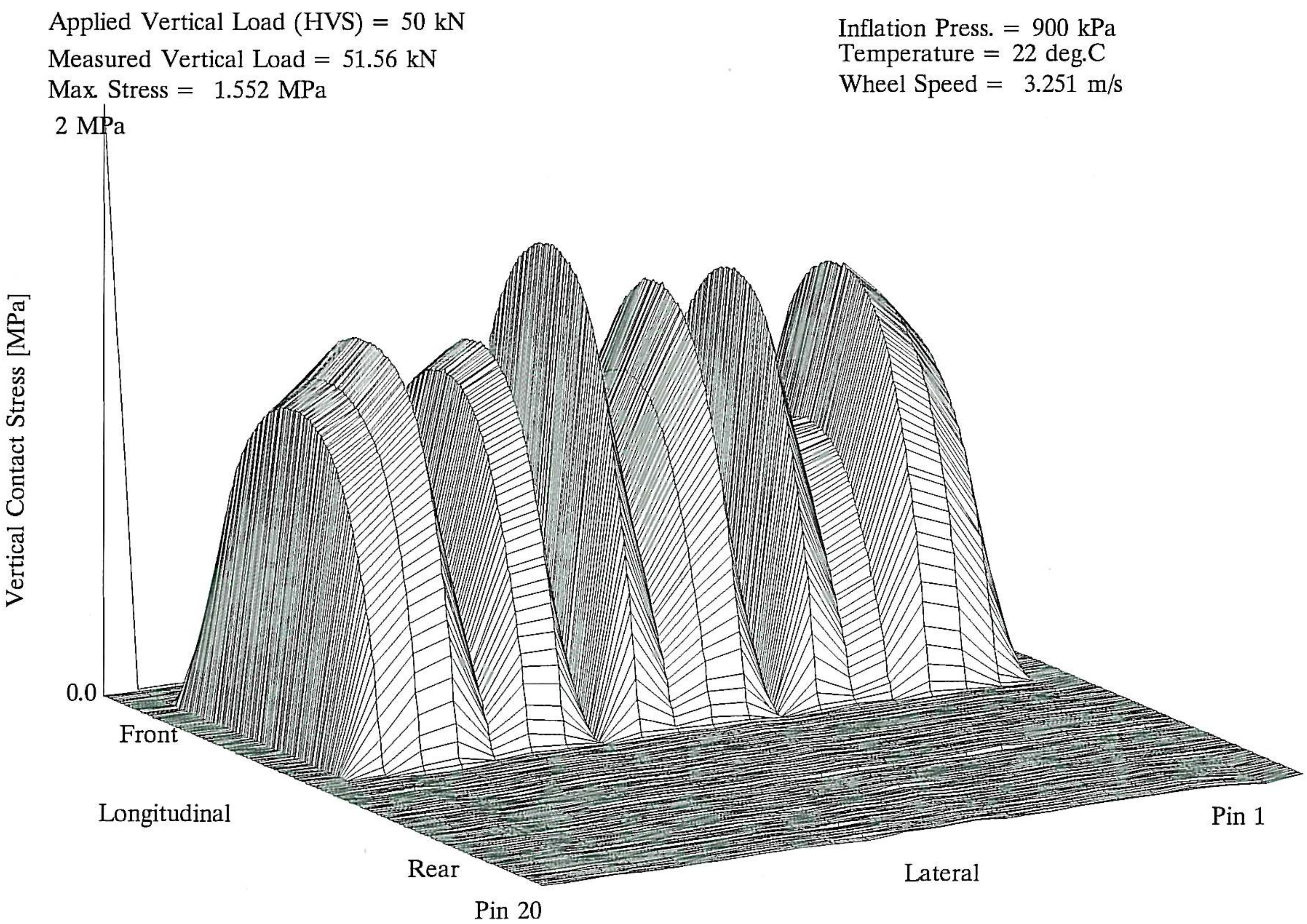
Inflation Press. = 900 kPa
Temperature = 21 deg.C
Wheel Speed = 3.347 m/s



New Bridgestone 425/65R22.5 R164BZ

Filename : nnt902ax

FIGURE F8X



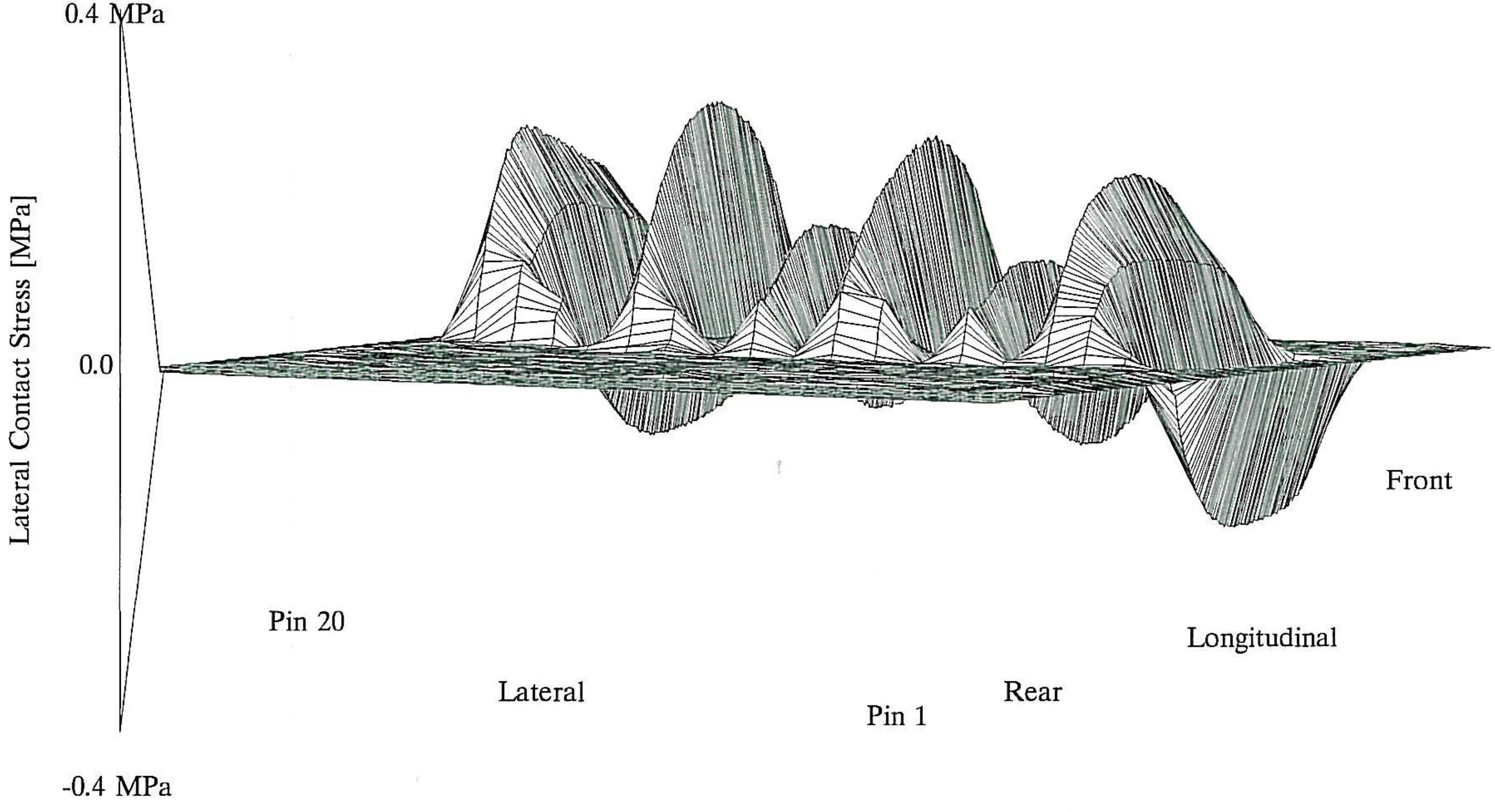
New Bridgestone 425/65R22.5 R164BZ

Filename : nnt905az

FIGURE F9Z

Applied Vertical Load (HVS) = 50 kN
Measured Lateral Load = 2.466 kN
Max. Stress = 0.2666 MPa
Min. Stress = -0.1816 MPa

Inflation Press. = 900 kPa
Temperature = 22 deg.C
Wheel Speed = 3.251 m/s



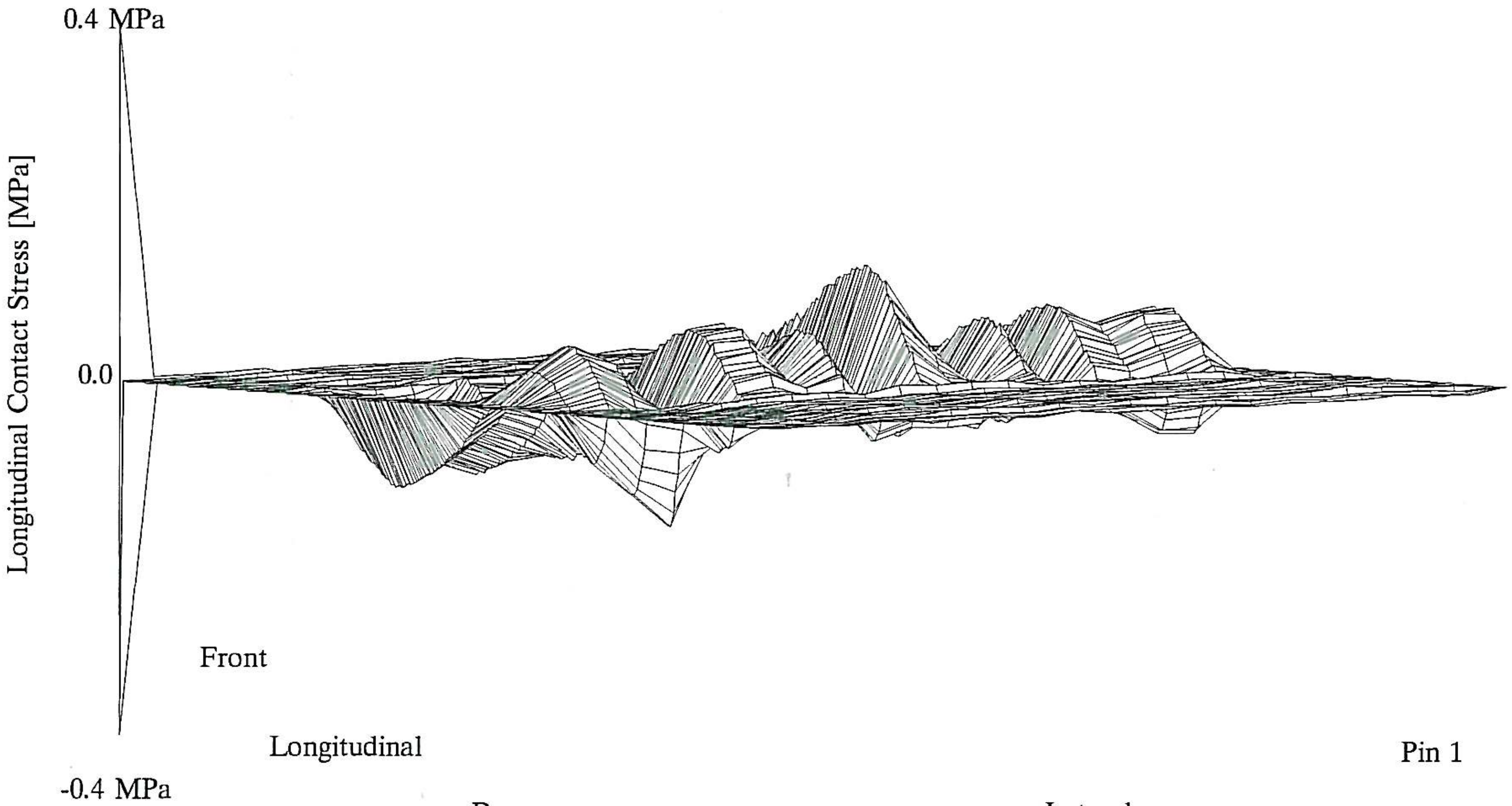
New Bridgestone 425/65R22.5 R164BZ

Filename : nnt905ay

FIGURE F9Y

Applied Vertical Load (HVS) = 50 kN
Measured Longitudinal Load = -0.1835 kN
Max. Stress = 0.1359 MPa
Min. Stress = -0.1392 MPa

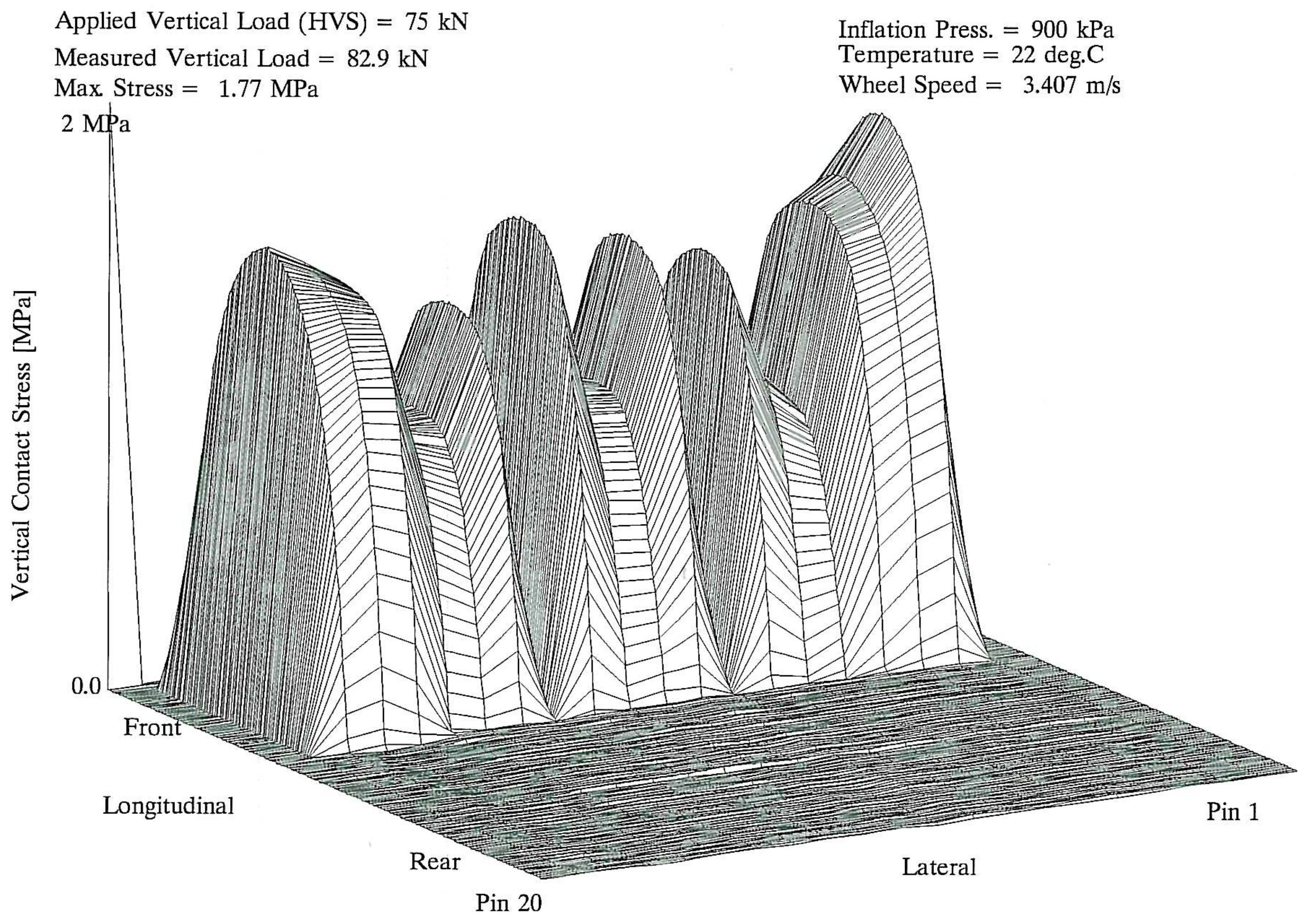
Inflation Press. = 900 kPa
Temperature = 22 deg.C
Wheel Speed = 3.251 m/s



New Bridgestone 425/65R22.5 R164BZ

Filename : nnt905ax

FIGURE F9X



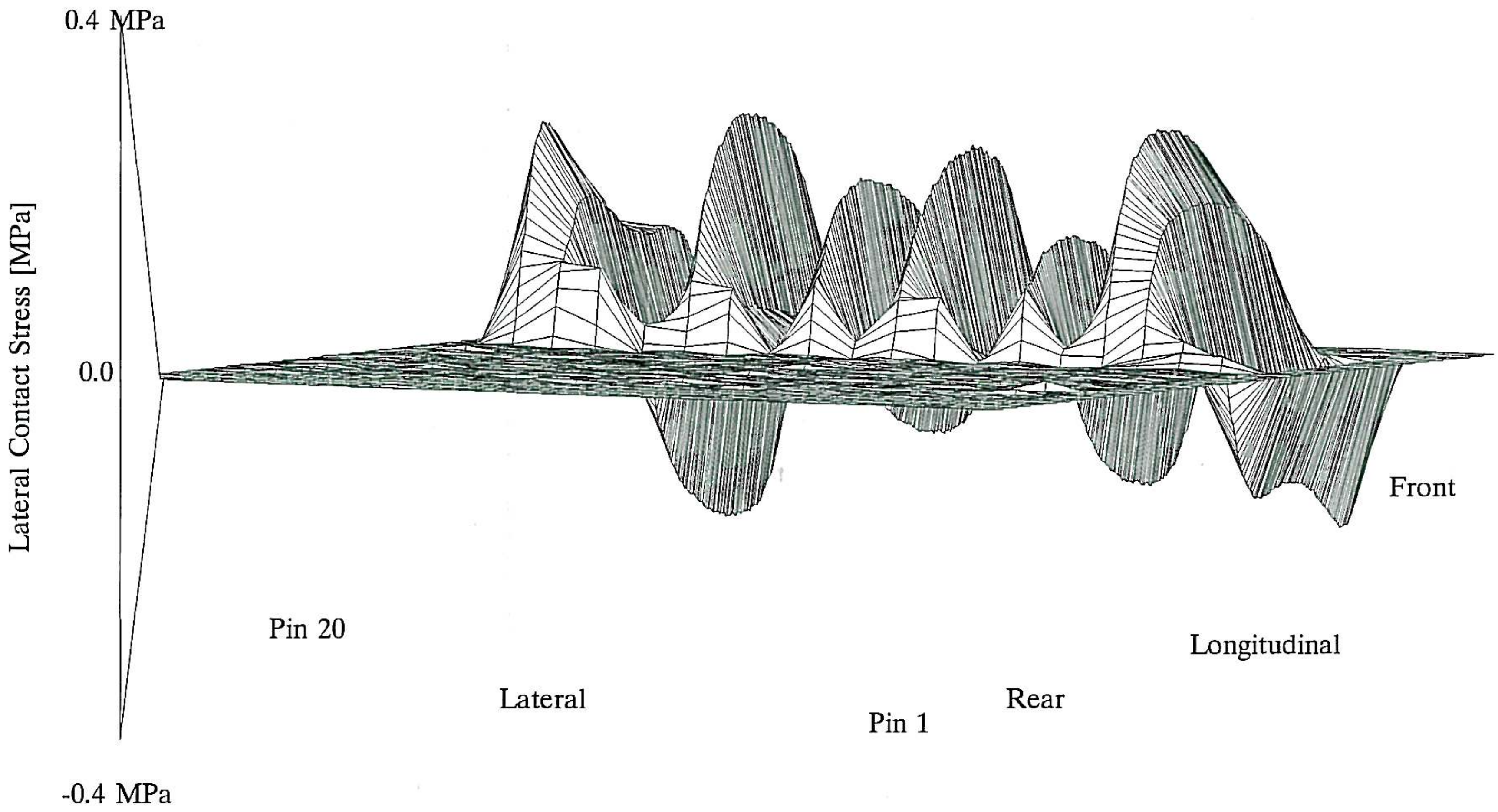
New Bridgestone 425/65R22.5 R164BZ

Filename : nnt907az

FIGURE F10Z

Applied Vertical Load (HVS) = 75 kN
Measured Lateral Load = 3.717 kN
Max. Stress = 0.2576 MPa
Min. Stress = -0.194 MPa

Inflation Press. = 900 kPa
Temperature = 22 deg.C
Wheel Speed = 3.407 m/s



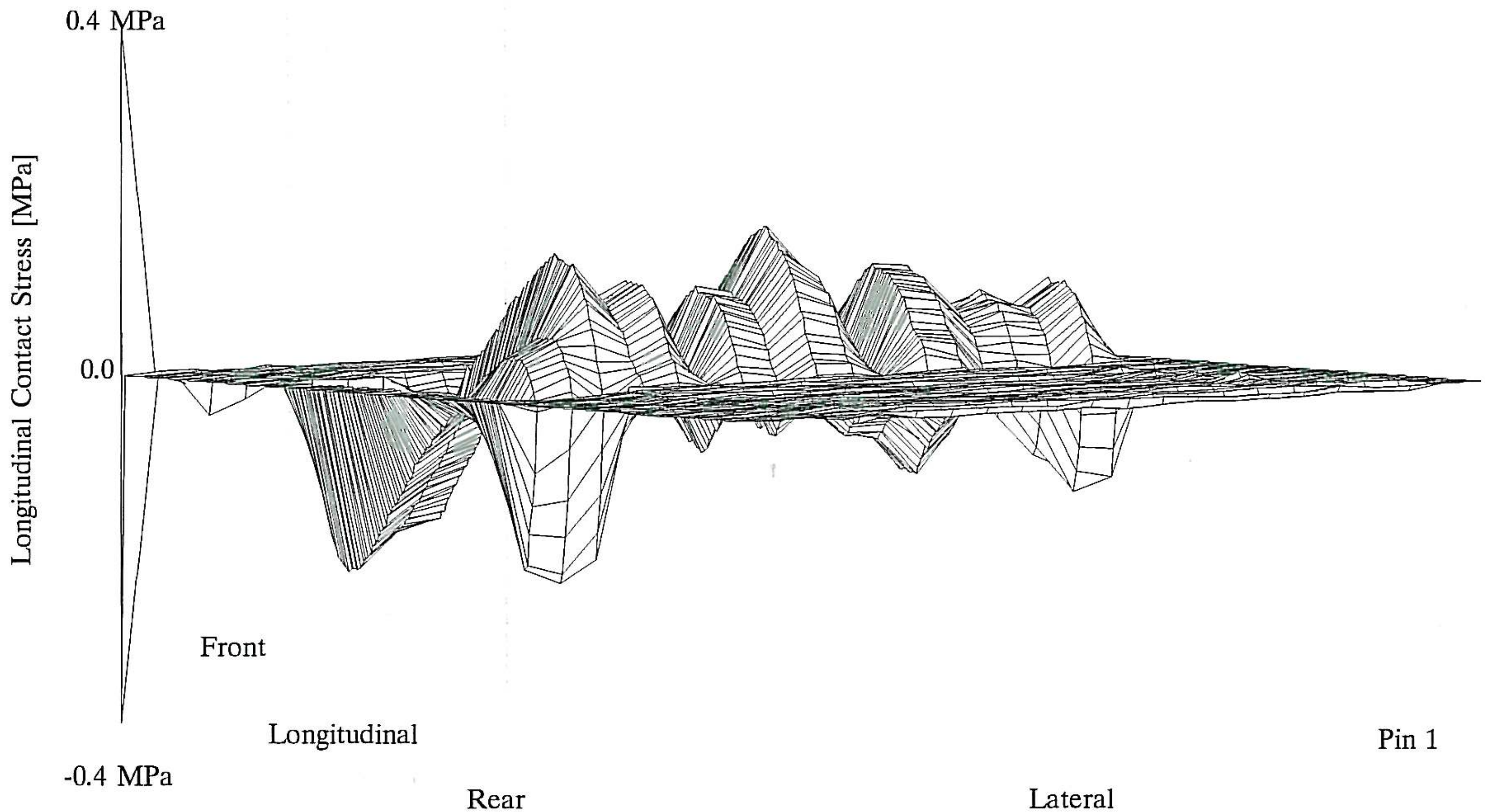
New Bridgestone 425/65R22.5 R164BZ

FIGURE F10Y

Filename : nnt907ay

Applied Vertical Load (HVS) = 75 kN
Measured Longitudinal Load = -0.9417 kN
Max. Stress = 0.1707 MPa
Min. Stress = -0.2188 MPa

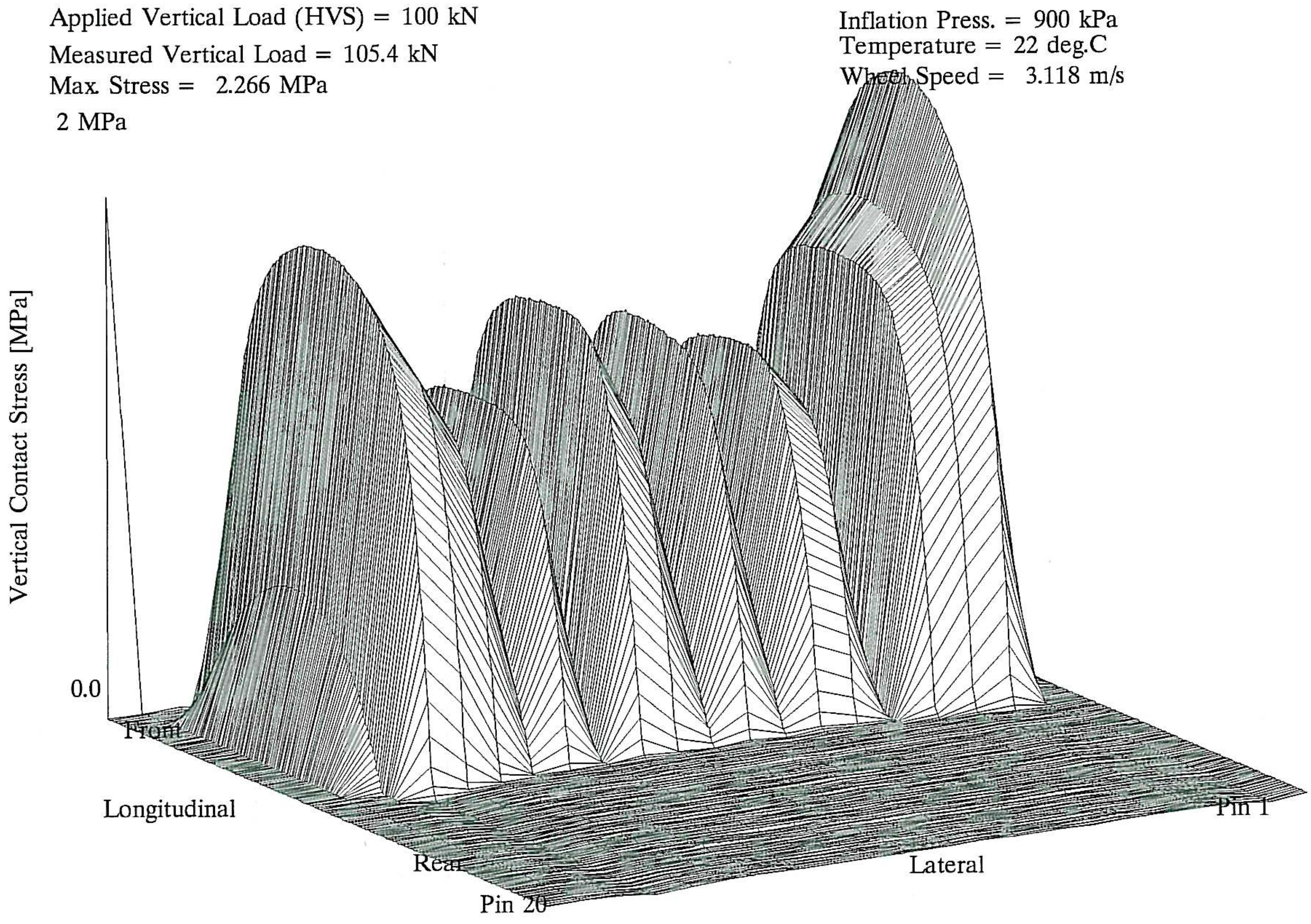
Inflation Press. = 900 kPa
Temperature = 22 deg.C
Wheel Speed = 3.407 m/s



New Bridgestone 425/65R22.5 R164BZ

Filename : nnt907ax

FIGURE F10X



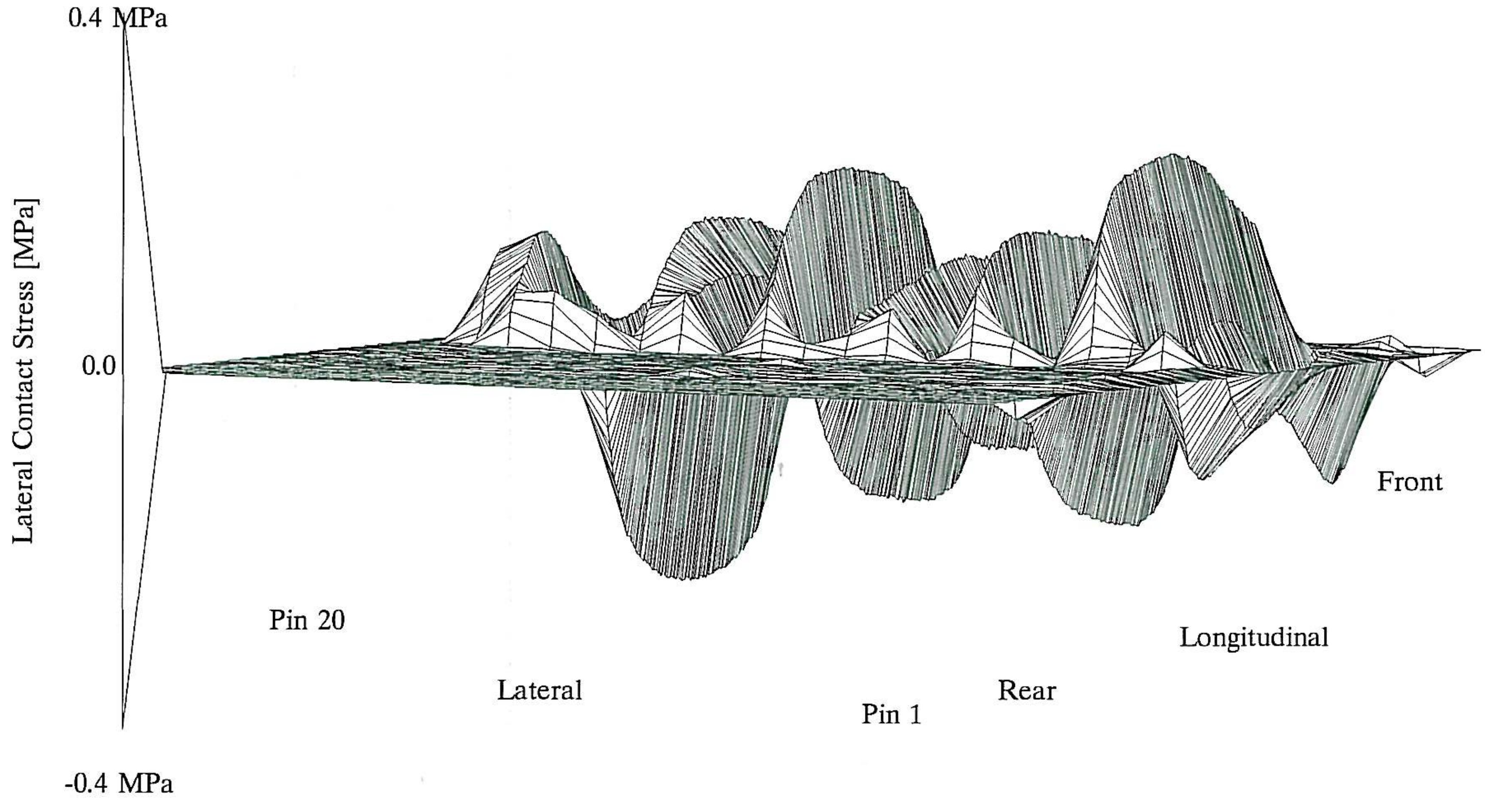
New Bridgestone 425/65R22.5 R164BZ

Filename : nnt901az

FIGURE F11Z

Applied Vertical Load (HVS) = 100 kN
Measured Lateral Load = 0.1284 kN
Max. Stress = 0.2299 MPa
Min. Stress = -0.2698 MPa

Inflation Press. = 900 kPa
Temperature = 22 deg.C
Wheel Speed = 3.118 m/s



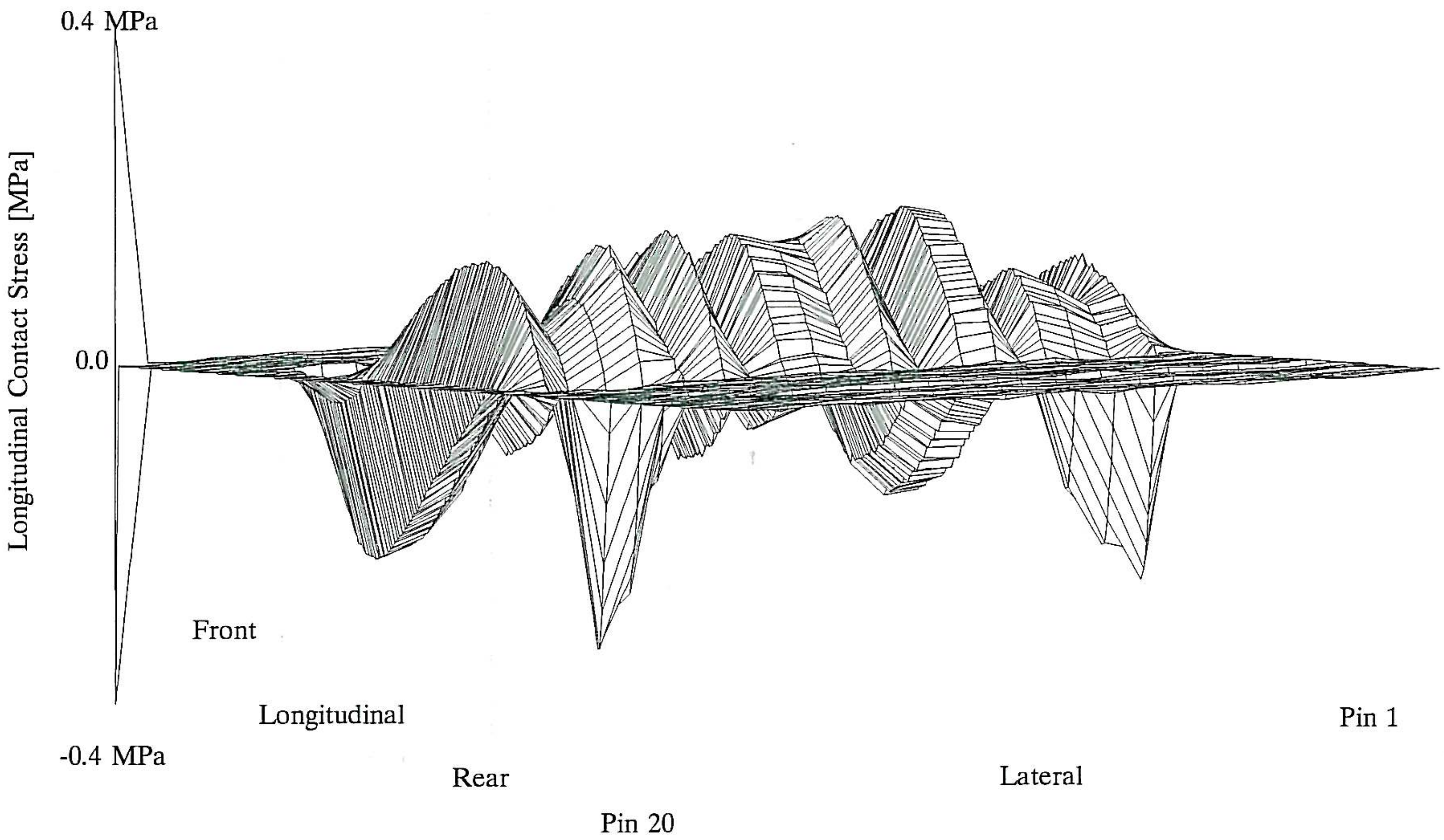
New Bridgestone 425/65R22.5 R164BZ

FIGURE F11Y

Filename : nnt901ay

Applied Vertical Load (HVS) = 100 kN
Measured Longitudinal Load = 0.4168 kN
Max. Stress = 0.1836 MPa
Min. Stress = -0.3103 MPa

Inflation Press. = 900 kPa
Temperature = 22 deg.C
Wheel Speed = 3.118 m/s



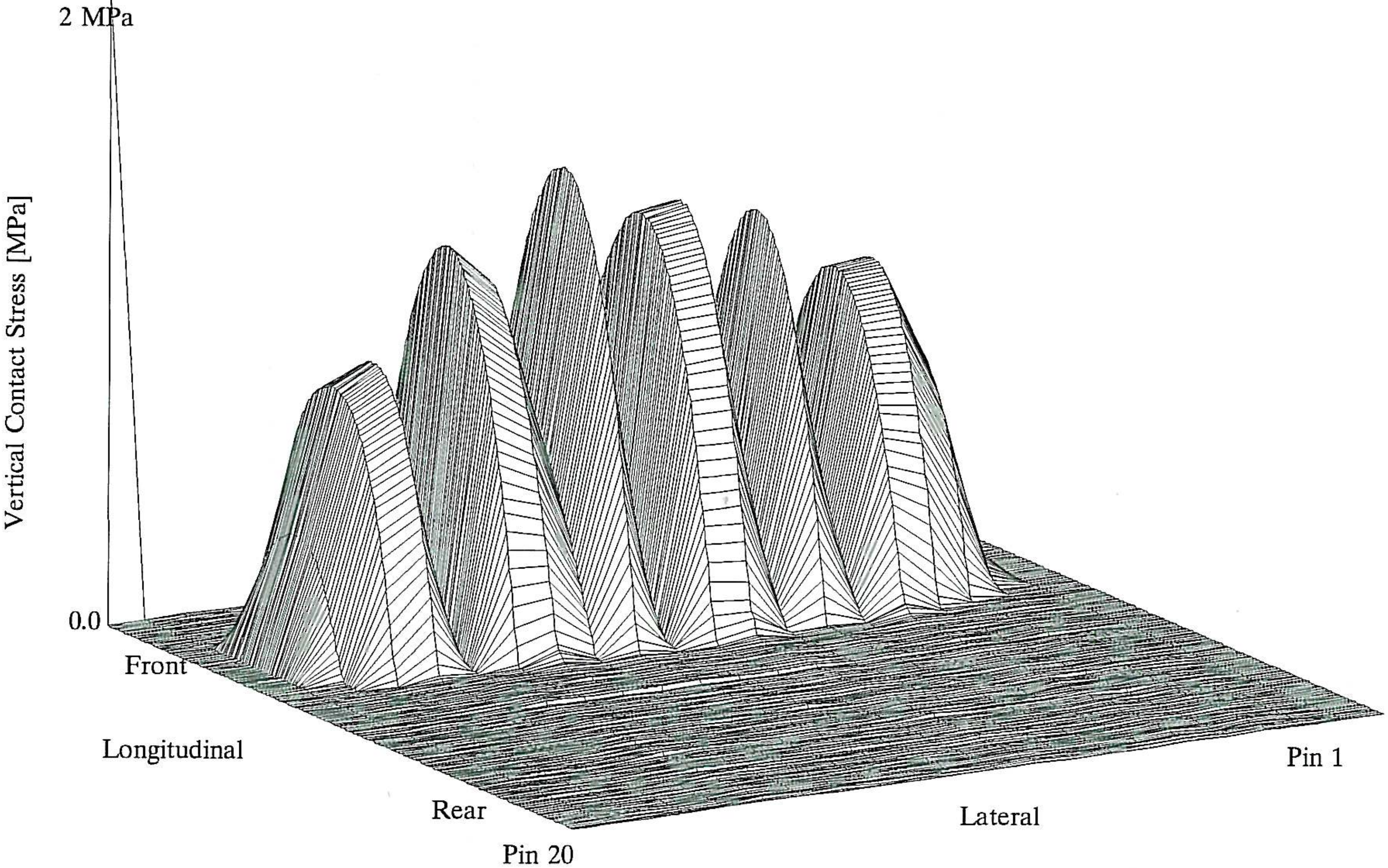
New Bridgestone 425/65R22.5 R164BZ

Filename : nnt901ax

FIGURE F11X

Applied Vertical Load (HVS) = 25 kN
Measured Vertical Load = 27.83 kN
Max. Stress = 1.448 MPa

Inflation Press. = 950 kPa
Temperature = 21 deg.C
Wheel Speed = 3.253 m/s



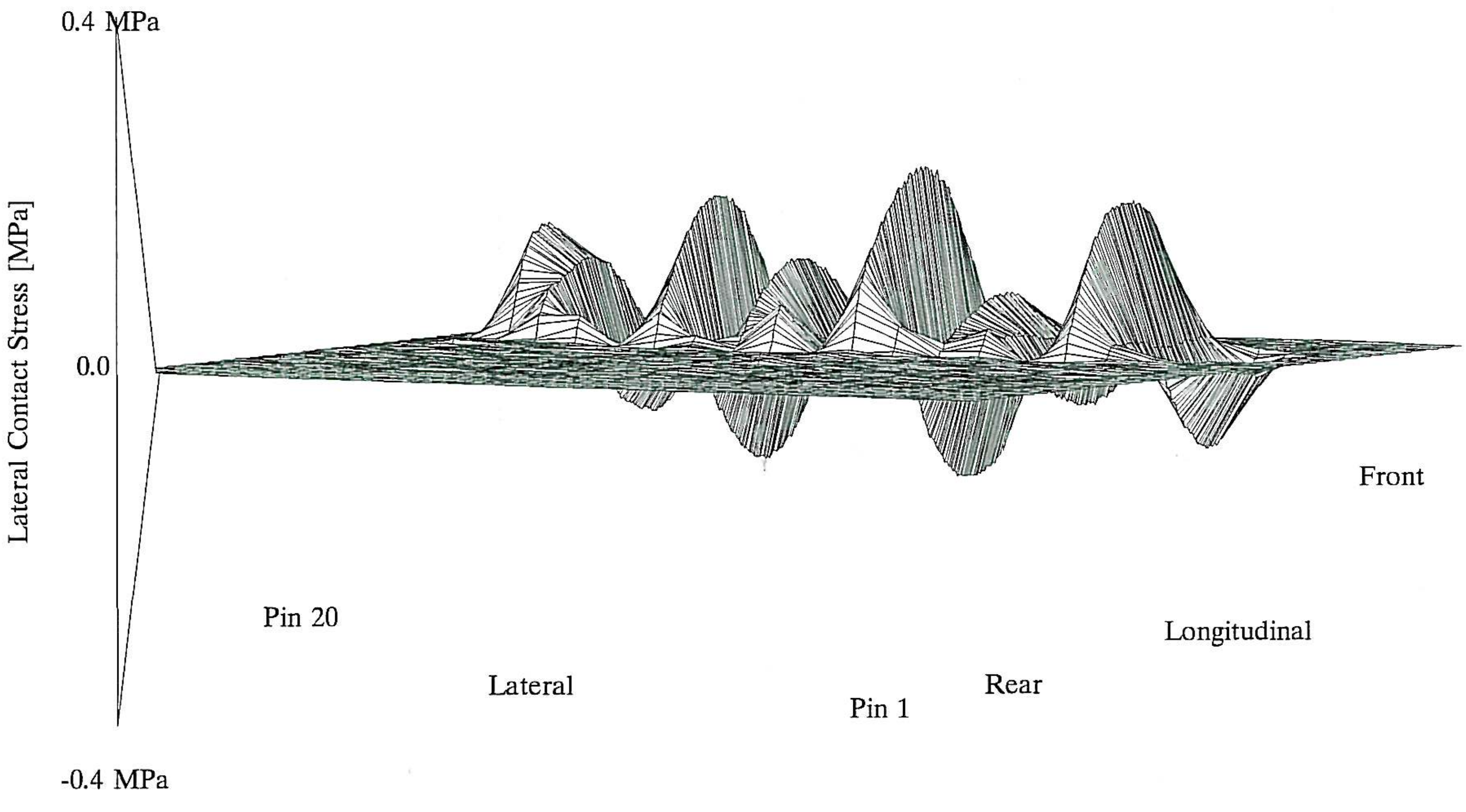
New Bridgestone 425/65R22.5 R164BZ

FIGURE F12Z

Filename : nnst92az

Applied Vertical Load (HVS) = 25 kN
Measured Lateral Load = 0.8186 kN
Max. Stress = 0.2047 MPa
Min. Stress = -0.146 MPa

Inflation Press. = 950 kPa
Temperature = 21 deg.C
Wheel Speed = 3.253 m/s



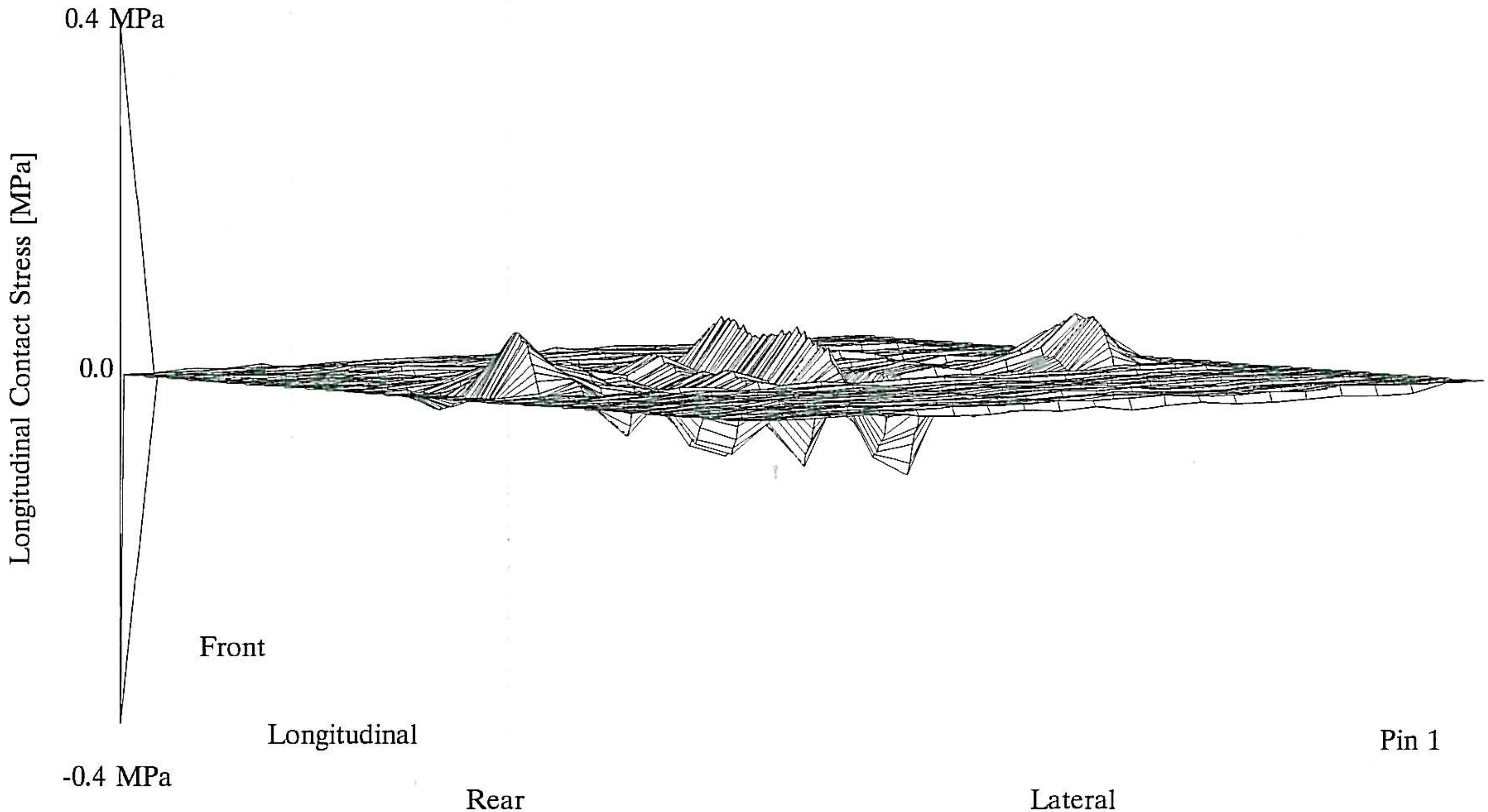
New Bridgestone 425/65R22.5 R164BZ

FIGURE F12Y

Filename : nnst92ay

Applied Vertical Load (HVS) = 25 kN
Measured Longitudinal Load = -0.4296 kN
Max. Stress = 0.07232 MPa
Min. Stress = -0.1098 MPa

Inflation Press. = 950 kPa
Temperature = 21 deg.C
Wheel Speed = 3.253 m/s



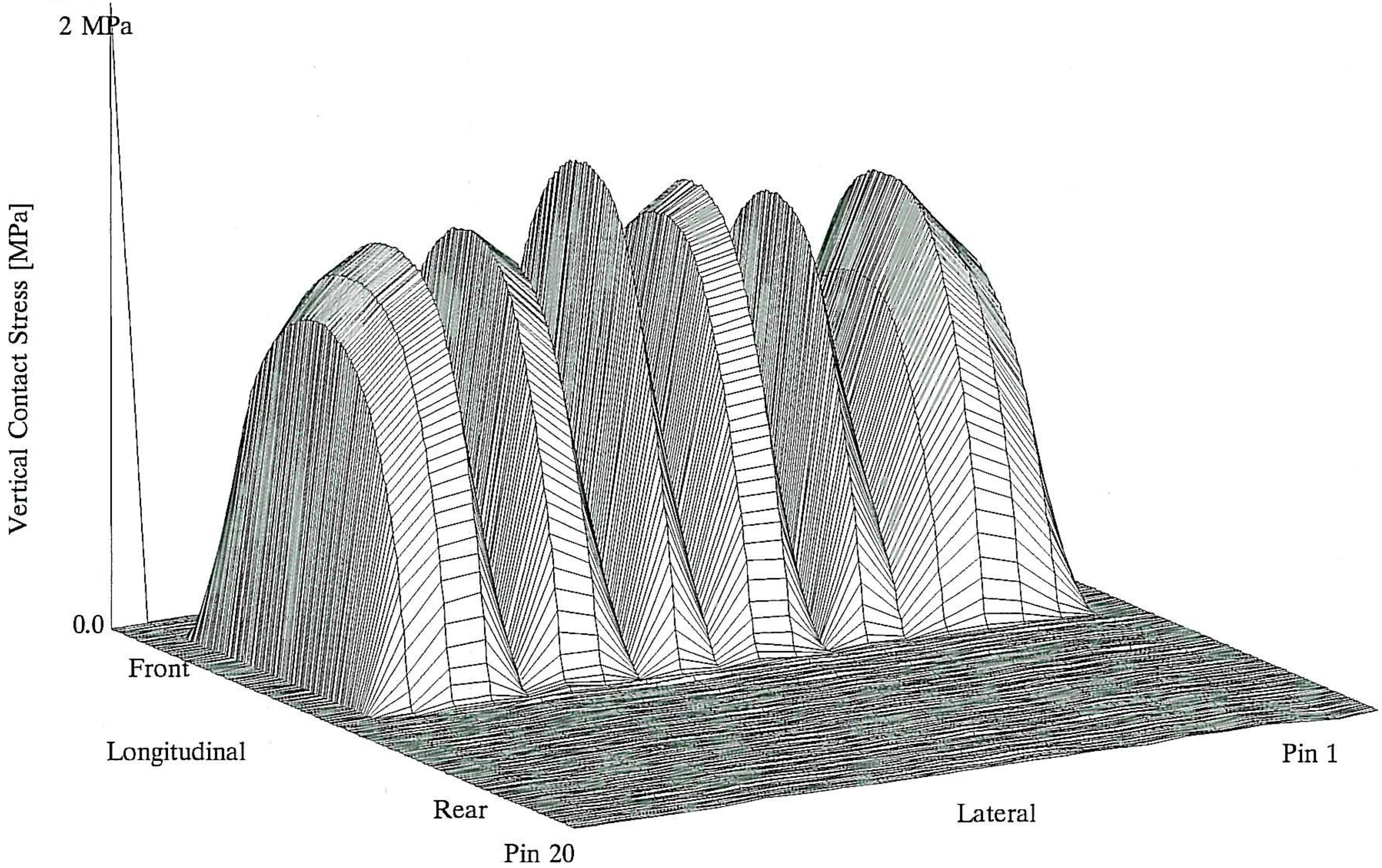
New Bridgestone 425/65R22.5 R164BZ

Filename : nnst92ax

FIGURE F12X

Applied Vertical Load (HVS) = 50 kN
Measured Vertical Load = 52.65 kN
Max. Stress = 1.51 MPa

Inflation Press. = 950 kPa
Temperature = 21 deg.C
Wheel Speed = 3.202 m/s



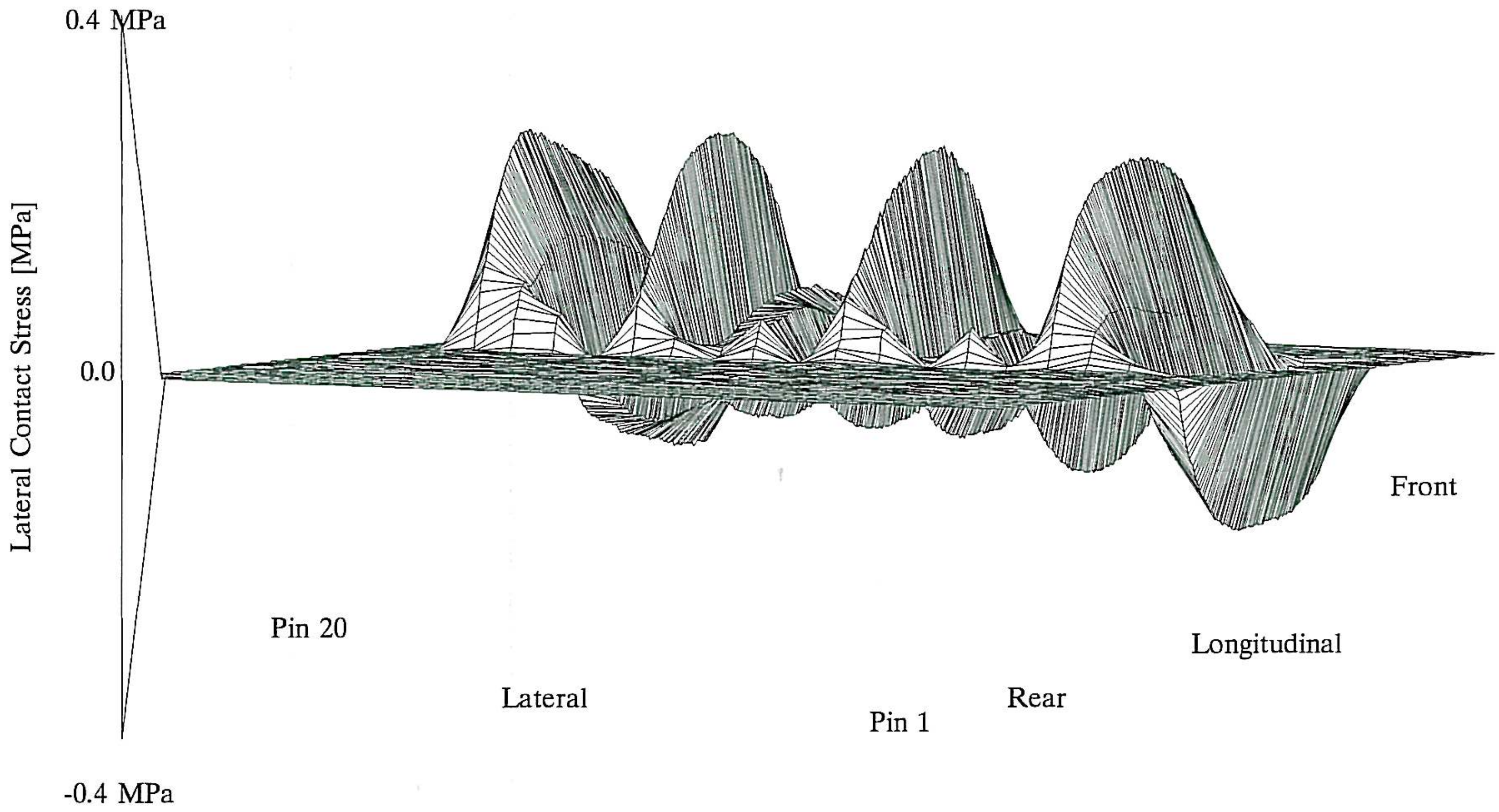
New Bridgestone 425/65R22.5 R164BZ

FIGURE F13Z

Filename : nnst95az

Applied Vertical Load (HVS) = 50 kN
Measured Lateral Load = 1.371 kN
Max. Stress = 0.2391 MPa
Min. Stress = -0.1796 MPa

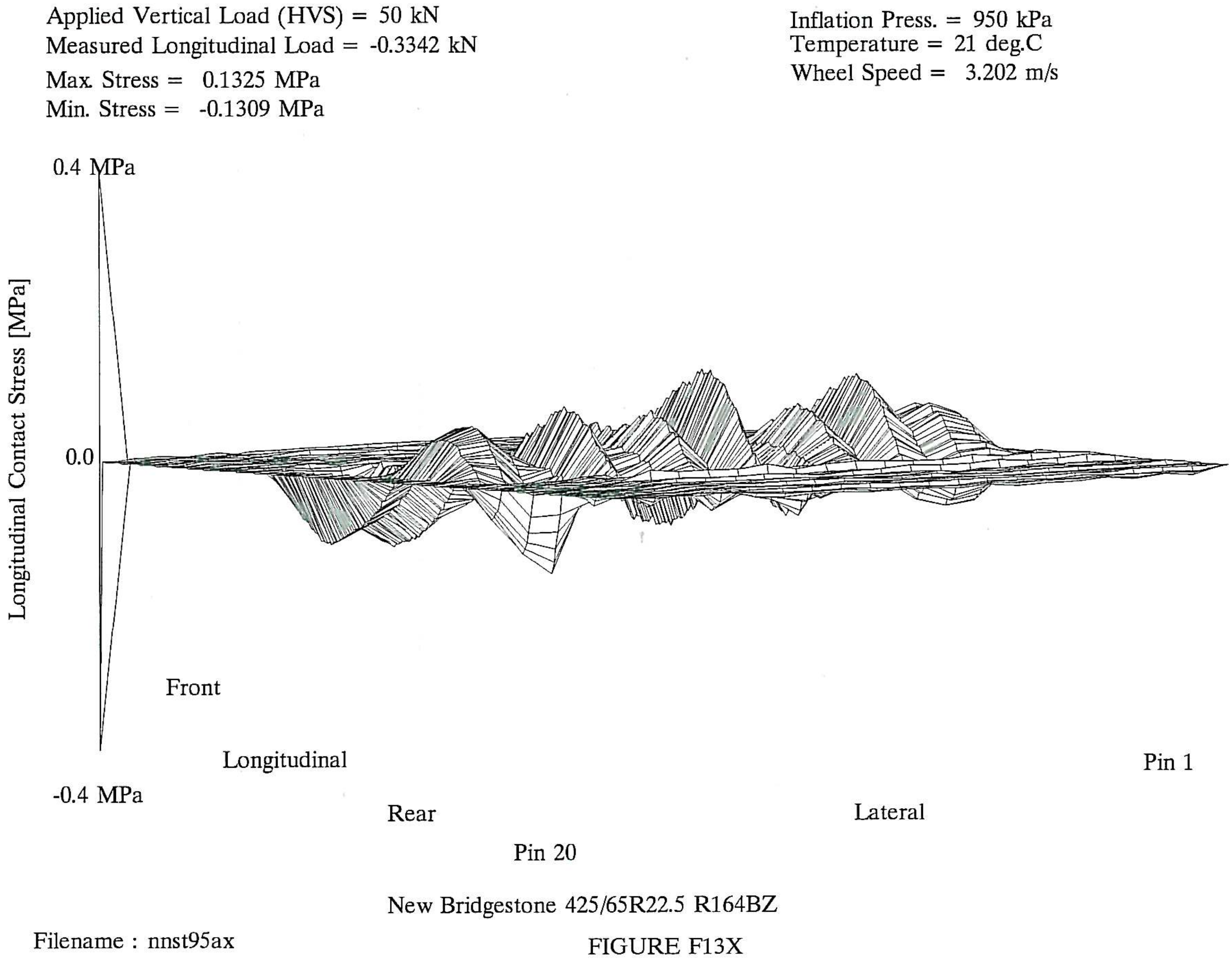
Inflation Press. = 950 kPa
Temperature = 21 deg.C
Wheel Speed = 3.202 m/s



New Bridgestone 425/65R22.5 R164BZ

FIGURE F13Y

Filename : nnst95ay

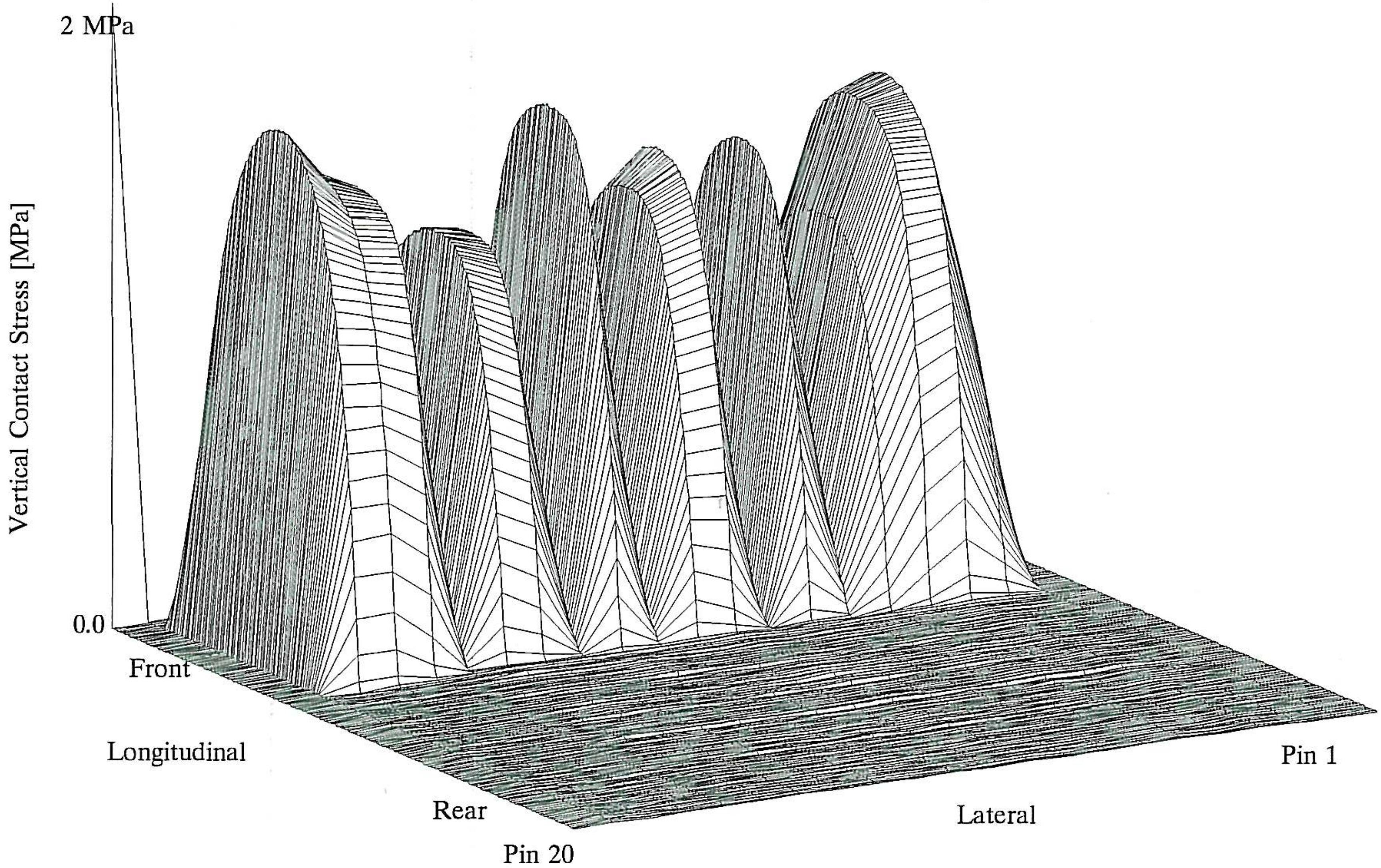


New Bridgestone 425/65R22.5 R164BZ

FIGURE F13X

Applied Vertical Load (HVS) = 75 kN
Measured Vertical Load = 76.04 kN
Max. Stress = 1.688 MPa

Inflation Press. = 950 kPa
Temperature = 21 deg.C
Wheel Speed = 3.406 m/s



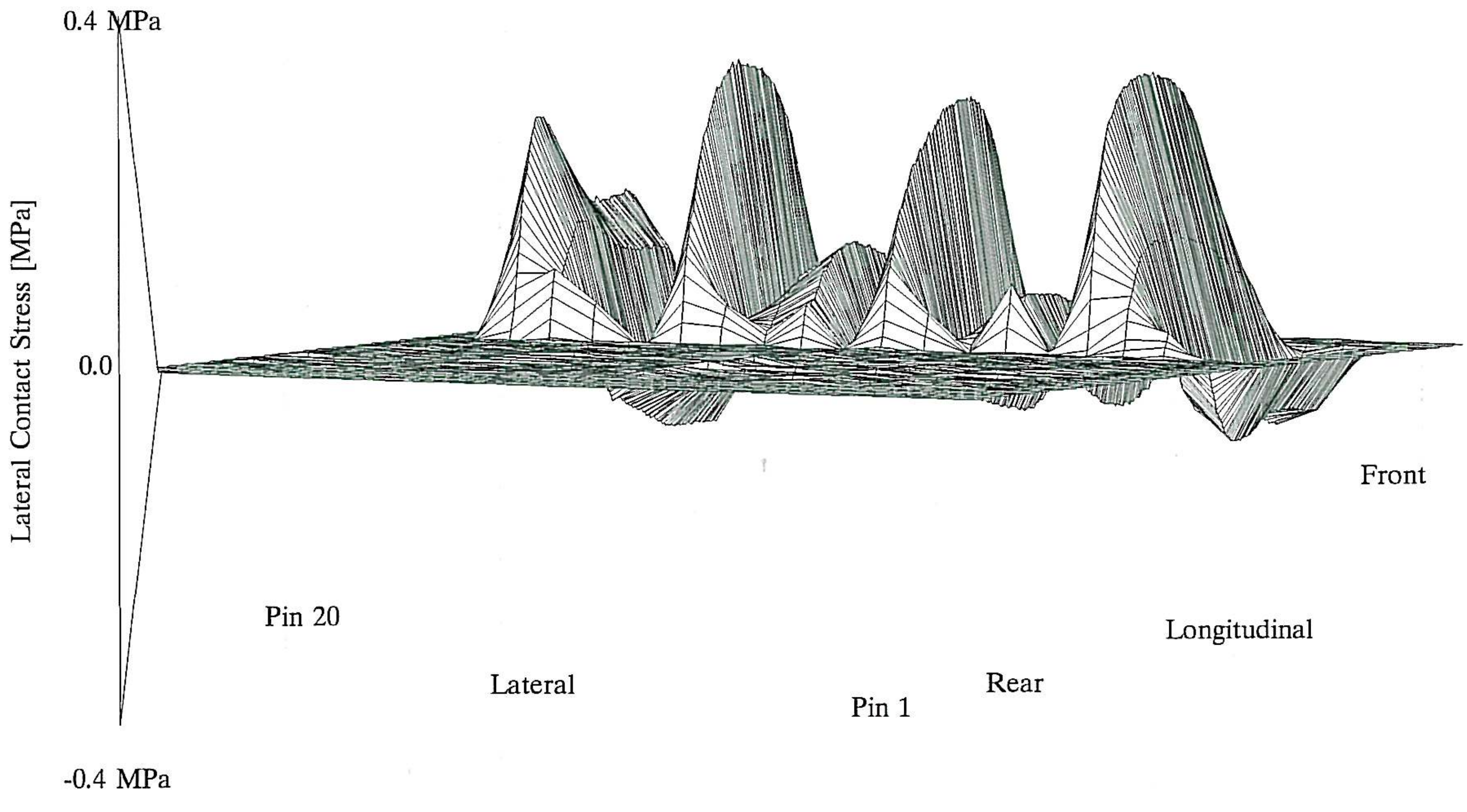
New Bridgestone 425/65R22.5 R164BZ

FIGURE F14Z

Filename : nnst97az

Applied Vertical Load (HVS) = 75 kN
Measured Lateral Load = 4.246 kN
Max. Stress = 0.3134 MPa
Min. Stress = -0.1057 MPa

Inflation Press. = 950 kPa
Temperature = 21 deg.C
Wheel Speed = 3.406 m/s



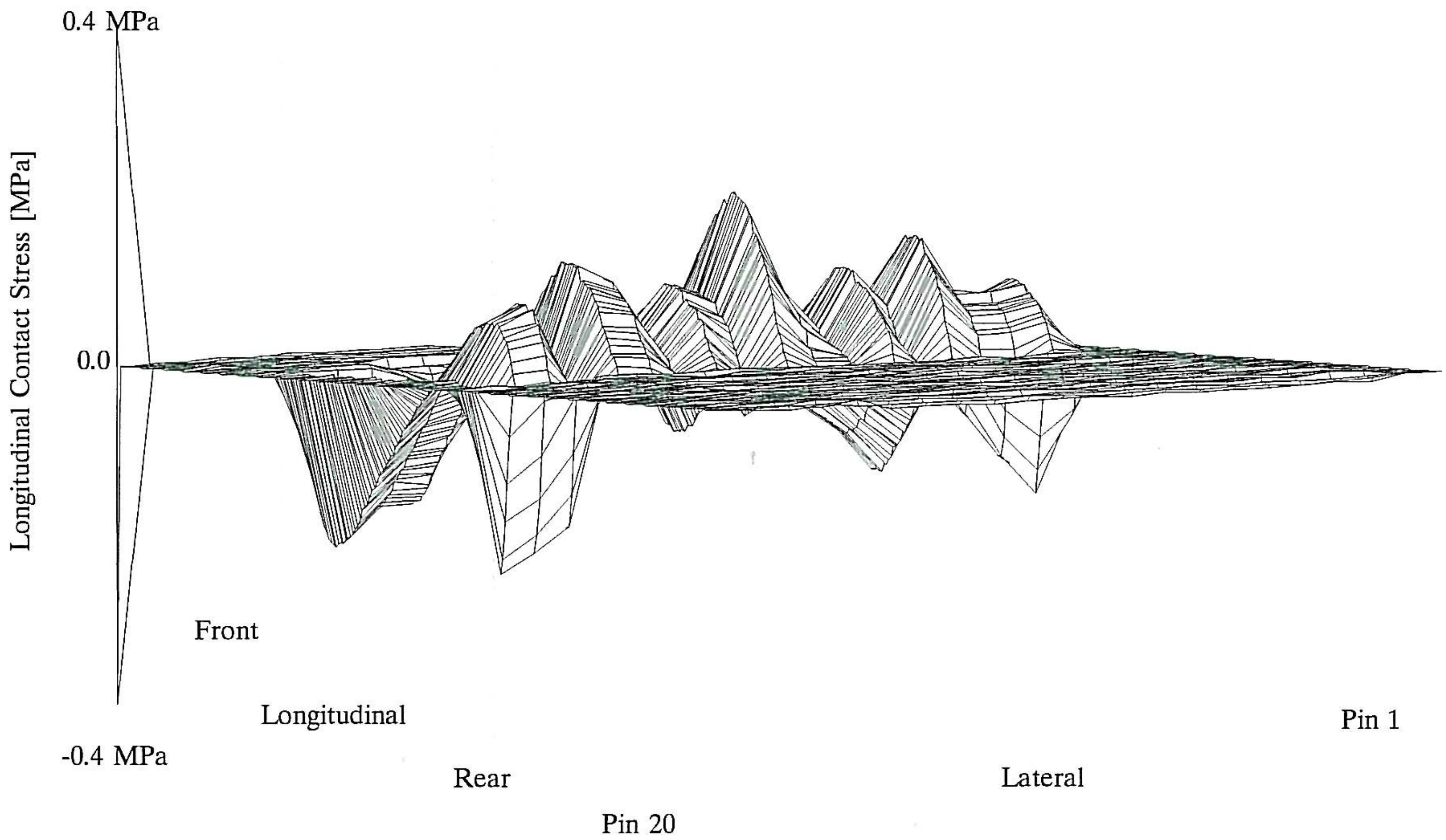
New Bridgestone 425/65R22.5 R164BZ

FIGURE F14Y

Filename : nnst97ay

Applied Vertical Load (HVS) = 75 kN
Measured Longitudinal Load = -0.459 kN
Max. Stress = 0.2029 MPa
Min. Stress = -0.2244 MPa

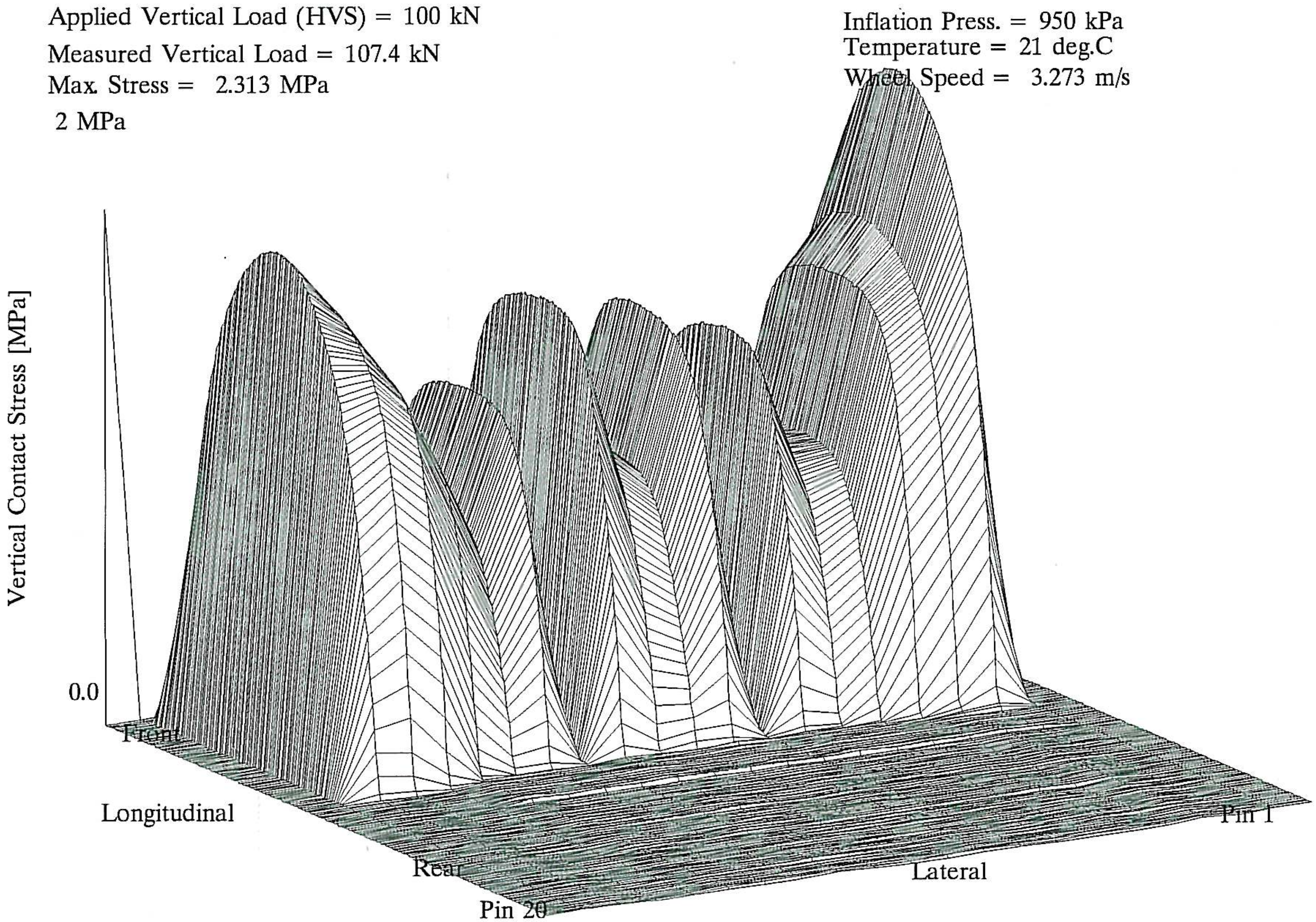
Inflation Press. = 950 kPa
Temperature = 21 deg.C
Wheel Speed = 3.406 m/s



New Bridgestone 425/65R22.5 R164BZ

Filename : nnst97ax

FIGURE F14X



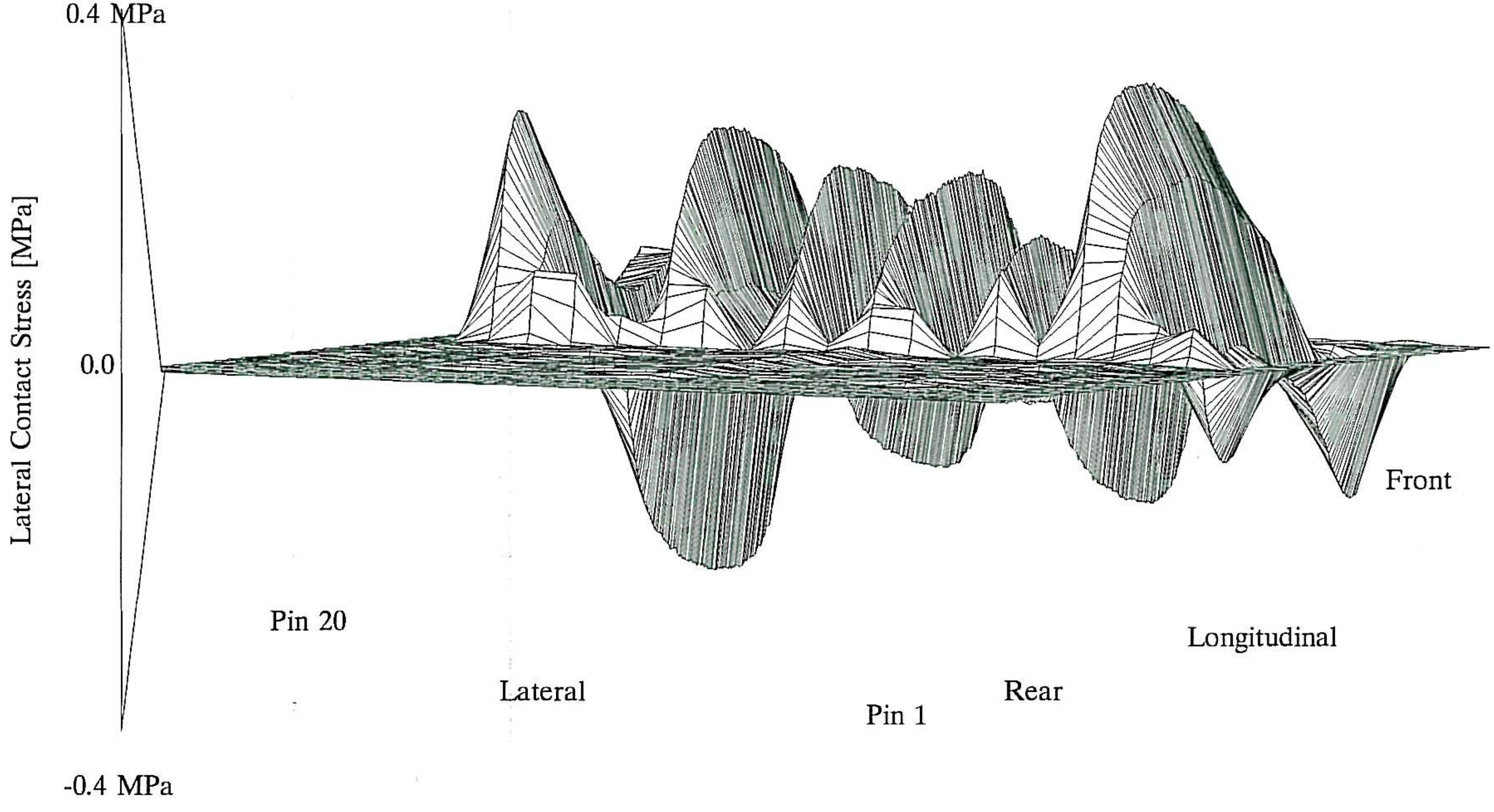
New Bridgestone 425/65R22.5 R164BZ

Filename : nnst91az

FIGURE F15Z

Applied Vertical Load (HVS) = 100 kN
Measured Lateral Load = 3.063 kN
Max. Stress = 0.3021 MPa
Min. Stress = -0.2615 MPa

Inflation Press. = 950 kPa
Temperature = 21 deg.C
Wheel Speed = 3.273 m/s



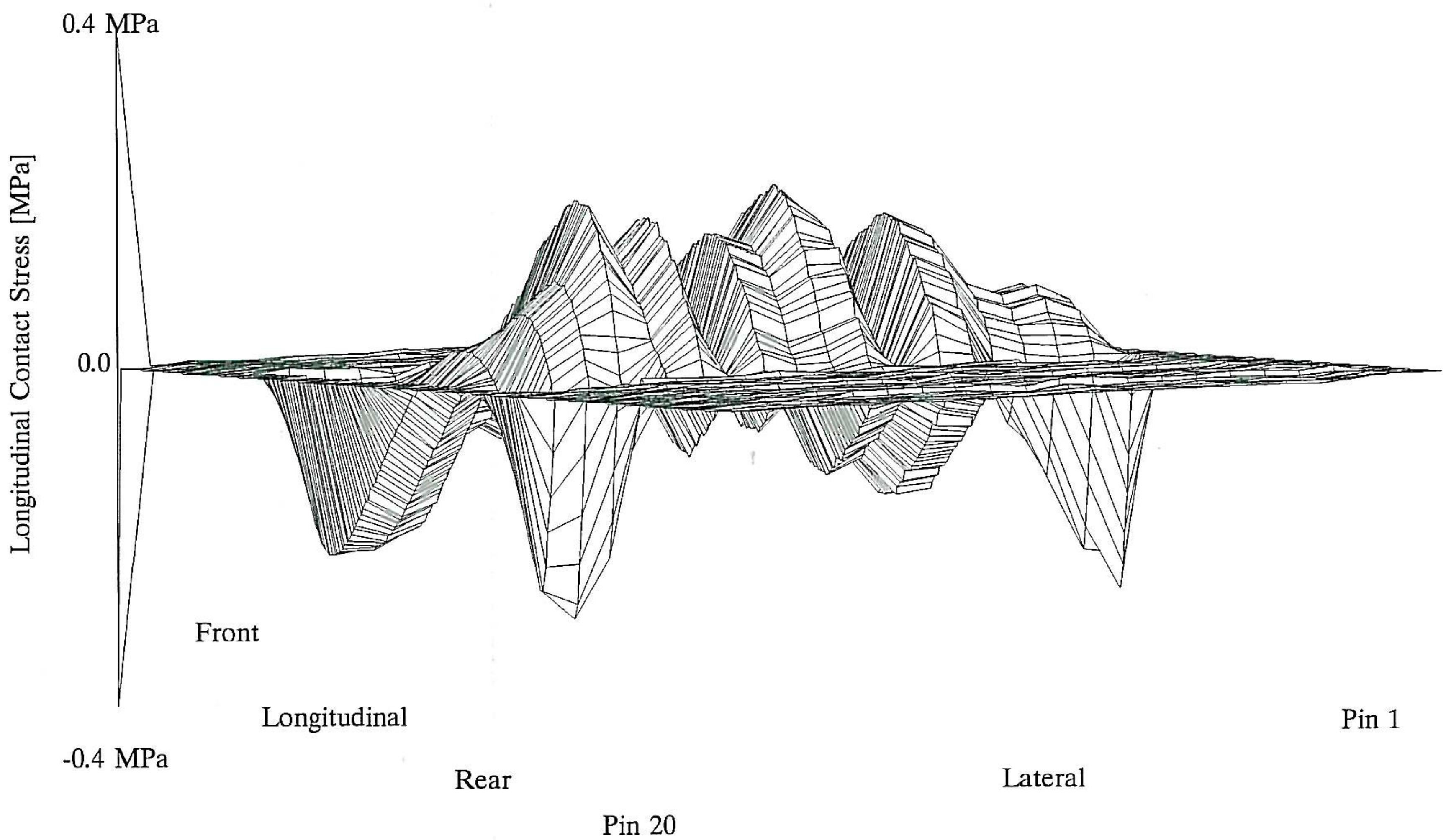
New Bridgestone 425/65R22.5 R164BZ

FIGURE F15Y

Filename : nnst91ay

Applied Vertical Load (HVS) = 100 kN
Measured Longitudinal Load = 0.09238 kN
Max. Stress = 0.2169 MPa
Min. Stress = -0.2741 MPa

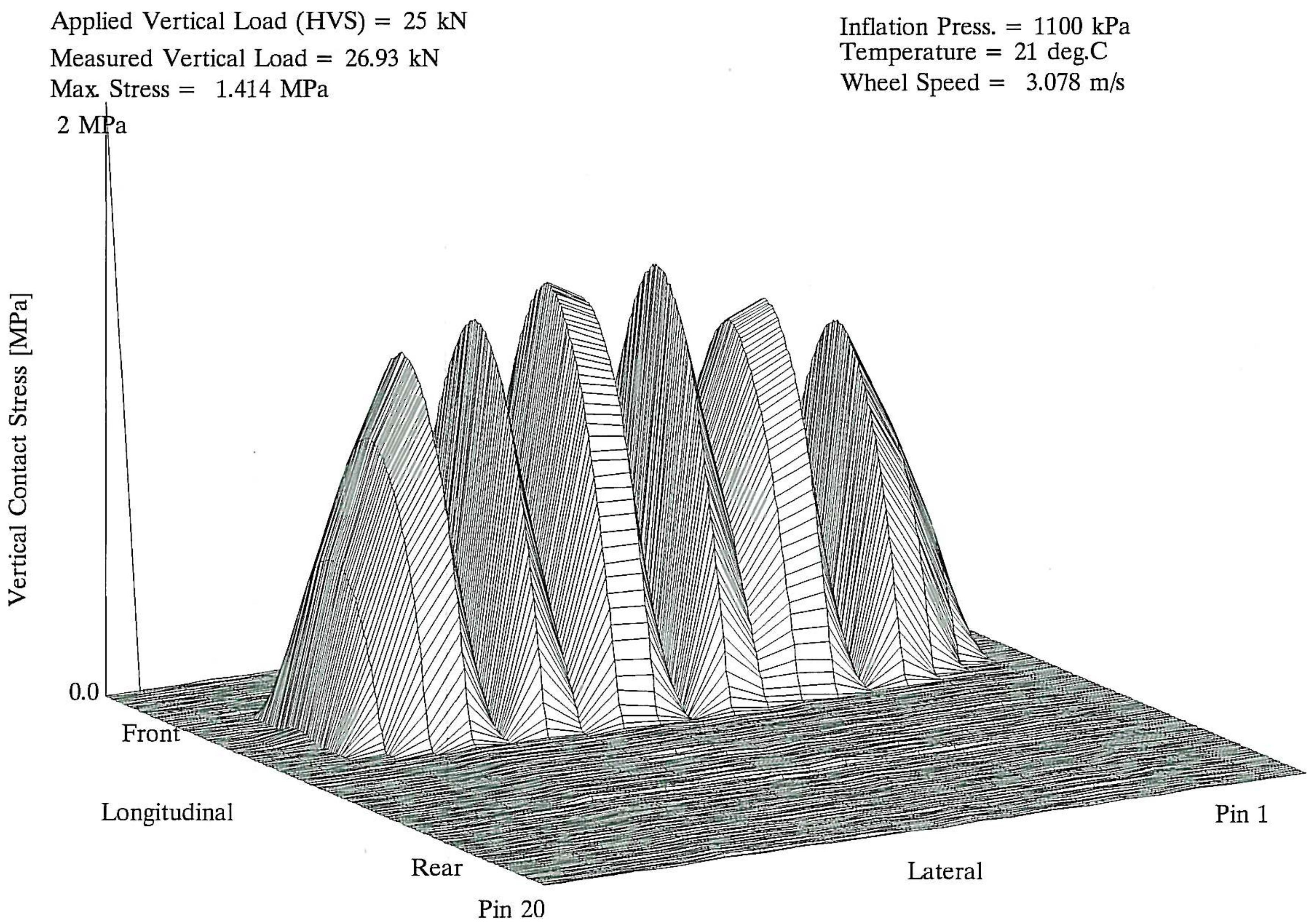
Inflation Press. = 950 kPa
Temperature = 21 deg.C
Wheel Speed = 3.273 m/s



New Bridgestone 425/65R22.5 R164BZ

Filename : nnst91ax

FIGURE F15X



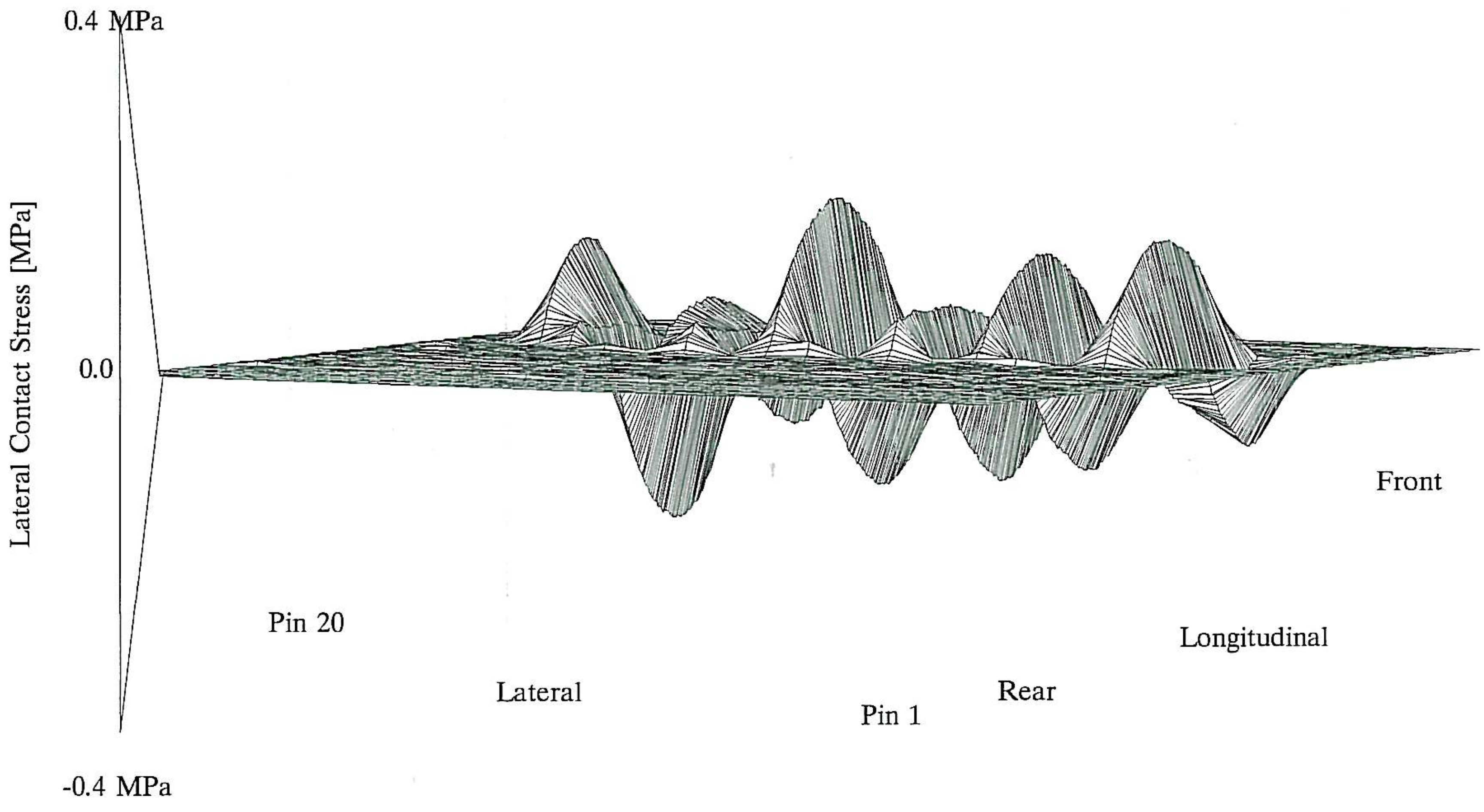
New Bridgestone 425/65R22.5 R164BZ

FIGURE F16Z

Filename : nnst12az

Applied Vertical Load (HVS) = 25 kN
Measured Lateral Load = -0.1981 kN
Max. Stress = 0.1702 MPa
Min. Stress = -0.196 MPa

Inflation Press. = 1100 kPa
Temperature = 21 deg.C
Wheel Speed = 3.078 m/s



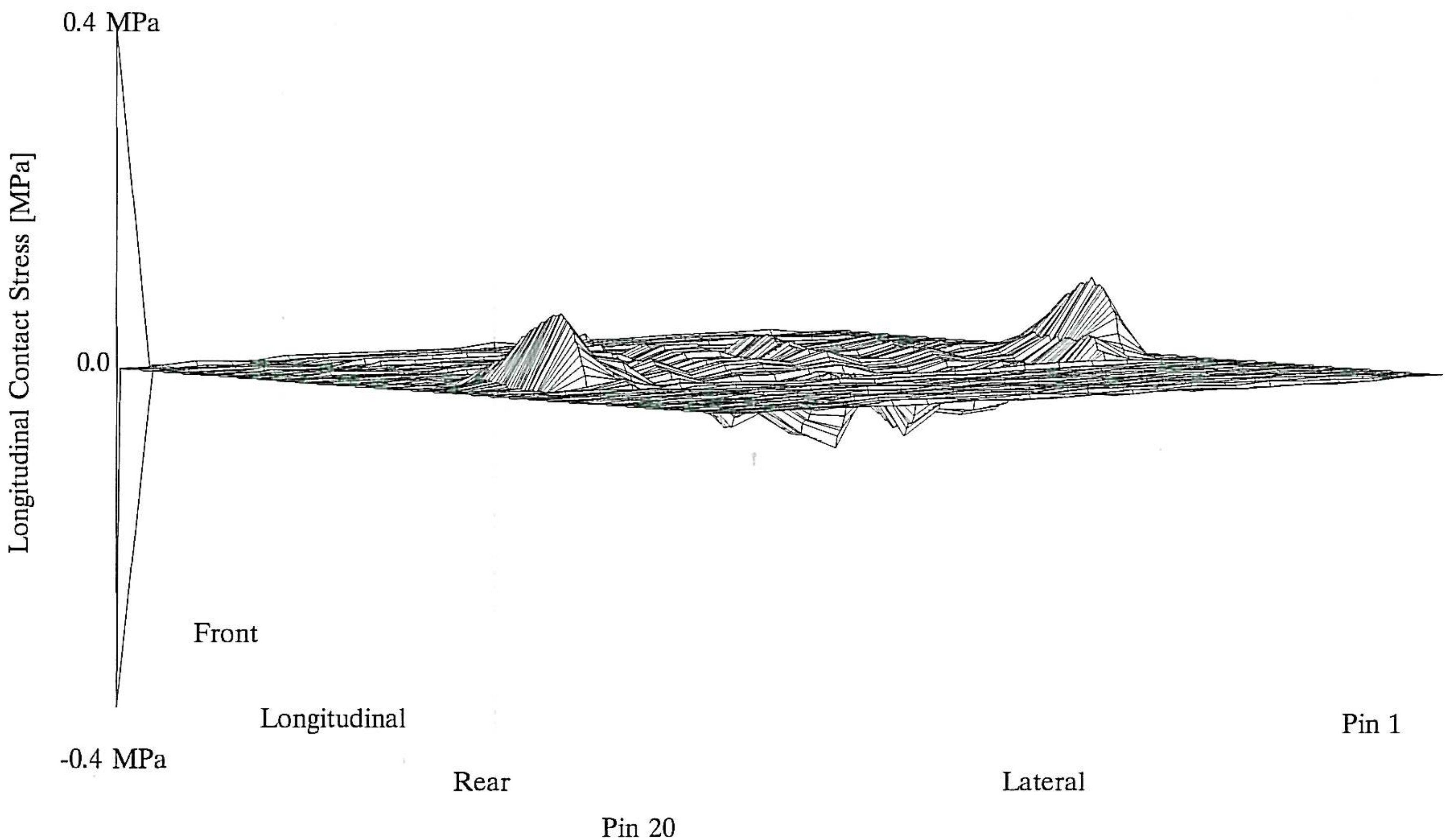
New Bridgestone 425/65R22.5 R164BZ

Filename : nnst12ay

FIGURE F16Y

Applied Vertical Load (HVS) = 25 kN
Measured Longitudinal Load = 0.1831 kN
Max. Stress = 0.09637 MPa
Min. Stress = -0.08207 MPa

Inflation Press. = 1100 kPa
Temperature = 21 deg.C
Wheel Speed = 3.078 m/s



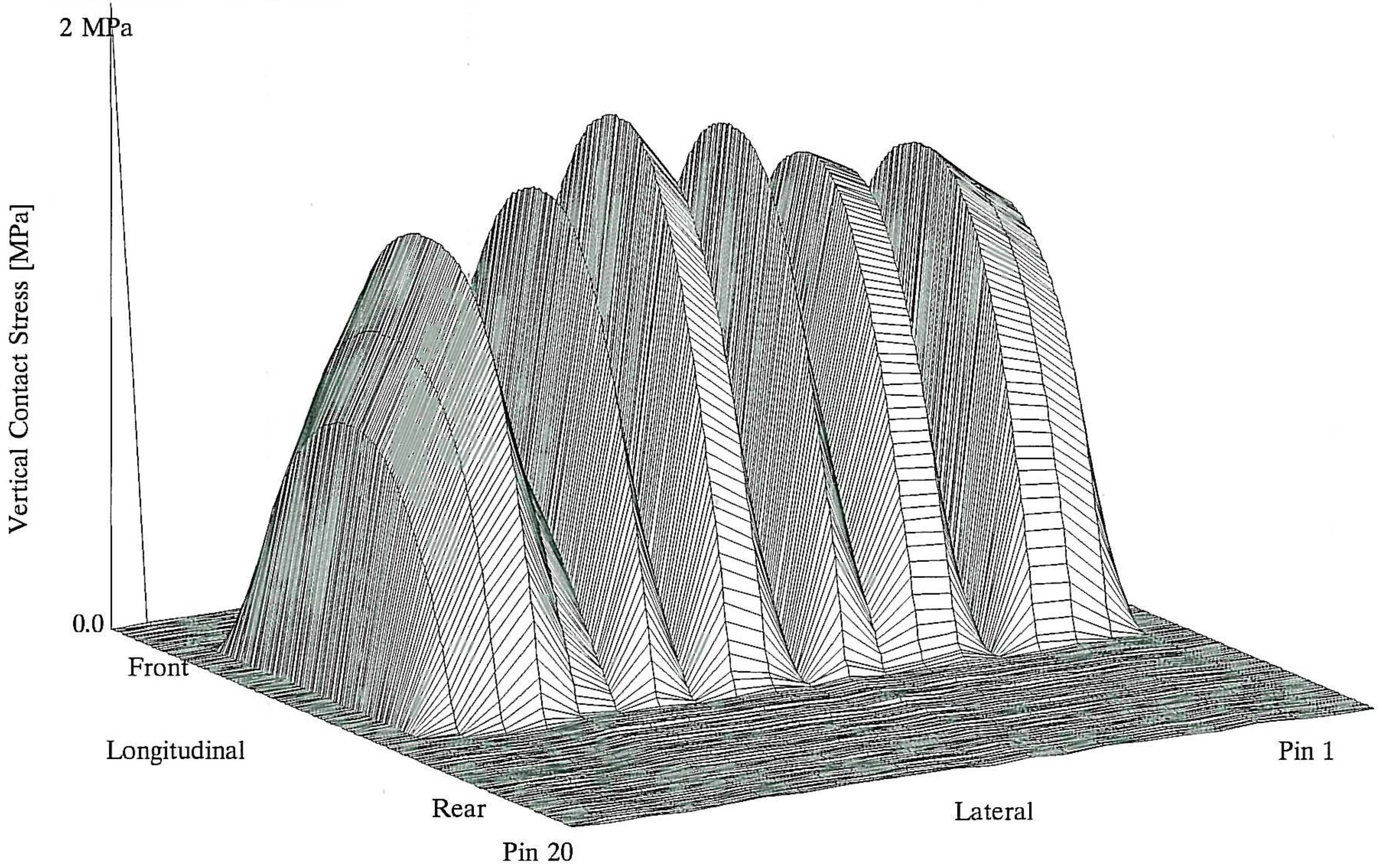
New Bridgestone 425/65R22.5 R164BZ

Filename : nnst12ax

FIGURE F16X

Applied Vertical Load (HVS) = 50 kN
Measured Vertical Load = 48.67 kN
Max. Stress = 1.708 MPa

Inflation Press. = 1100 kPa
Temperature = 20 deg.C
Wheel Speed = 2.405 m/s



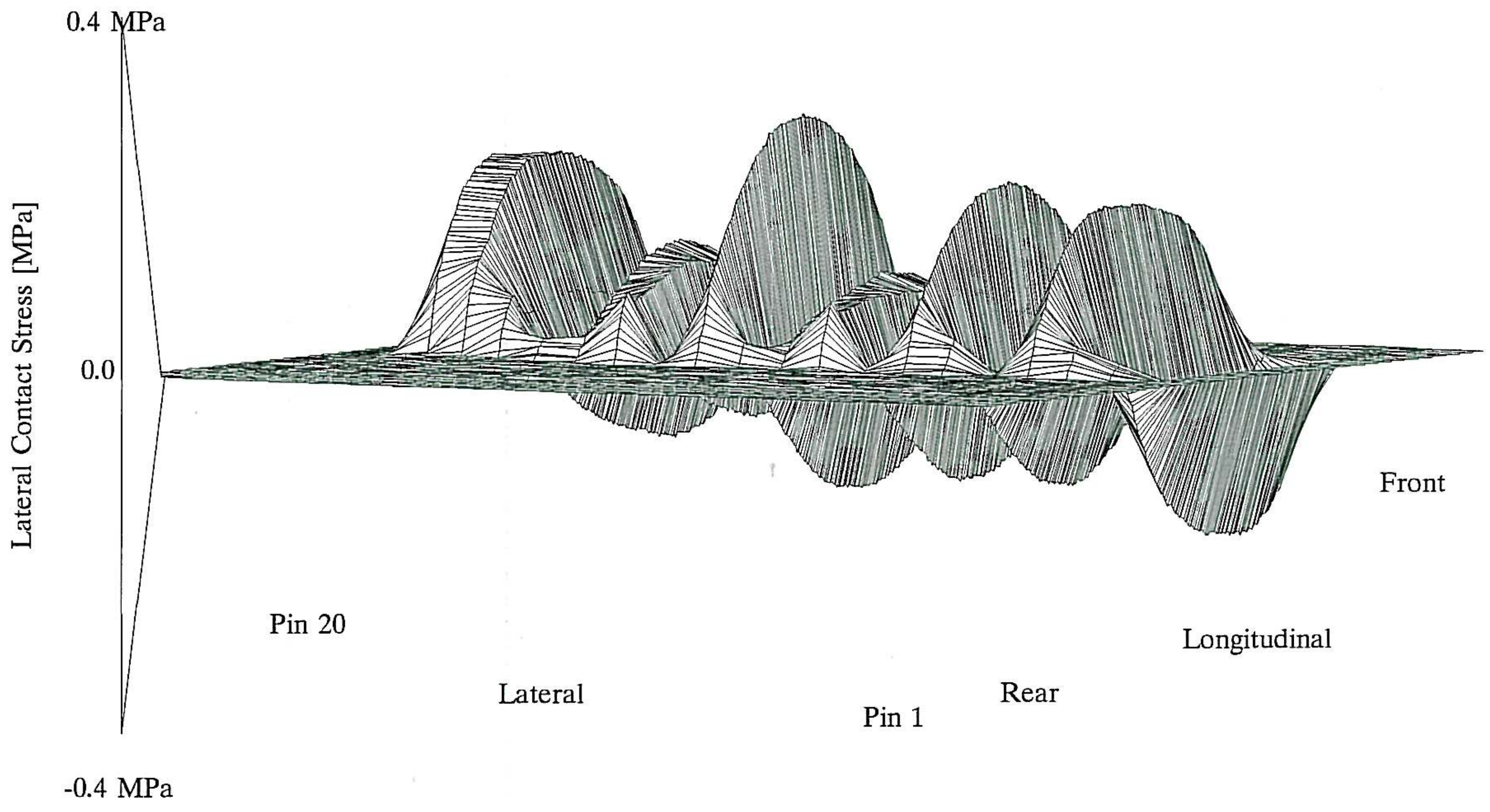
New Bridgestone 425/65R22.5 R164BZ

Filename : nnst15az

FIGURE F17Z

Applied Vertical Load (HVS) = 50 kN
Measured Lateral Load = 1.953 kN
Max. Stress = 0.2697 MPa
Min. Stress = -0.1903 MPa

Inflation Press. = 1100 kPa
Temperature = 20 deg.C
Wheel Speed = 2.405 m/s



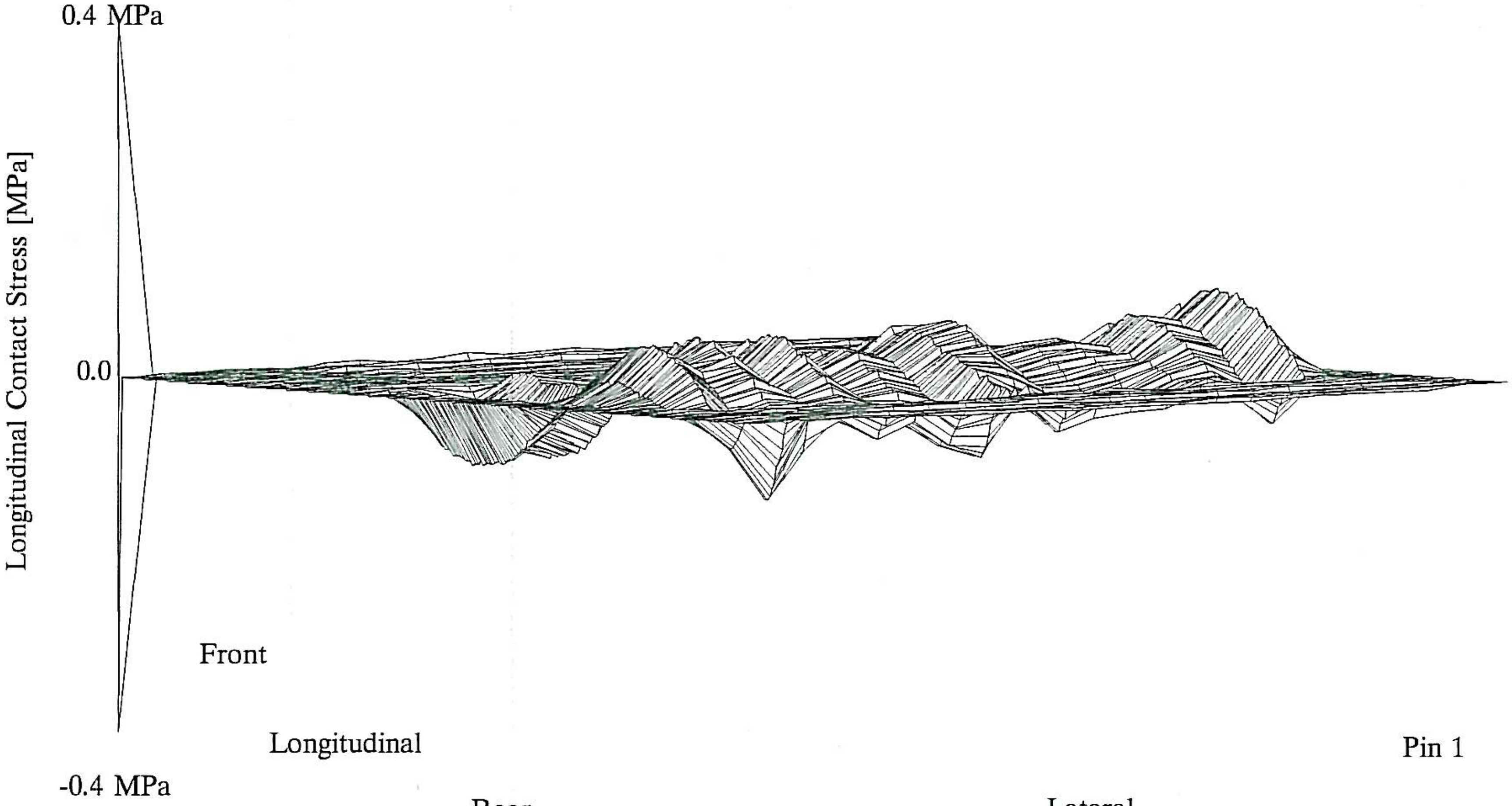
New Bridgestone 425/65R22.5 R164BZ

FIGURE F17Y

Filename : nnst15ay

Applied Vertical Load (HVS) = 50 kN
Measured Longitudinal Load = 0.1818 kN
Max. Stress = 0.09449 MPa
Min. Stress = -0.1058 MPa

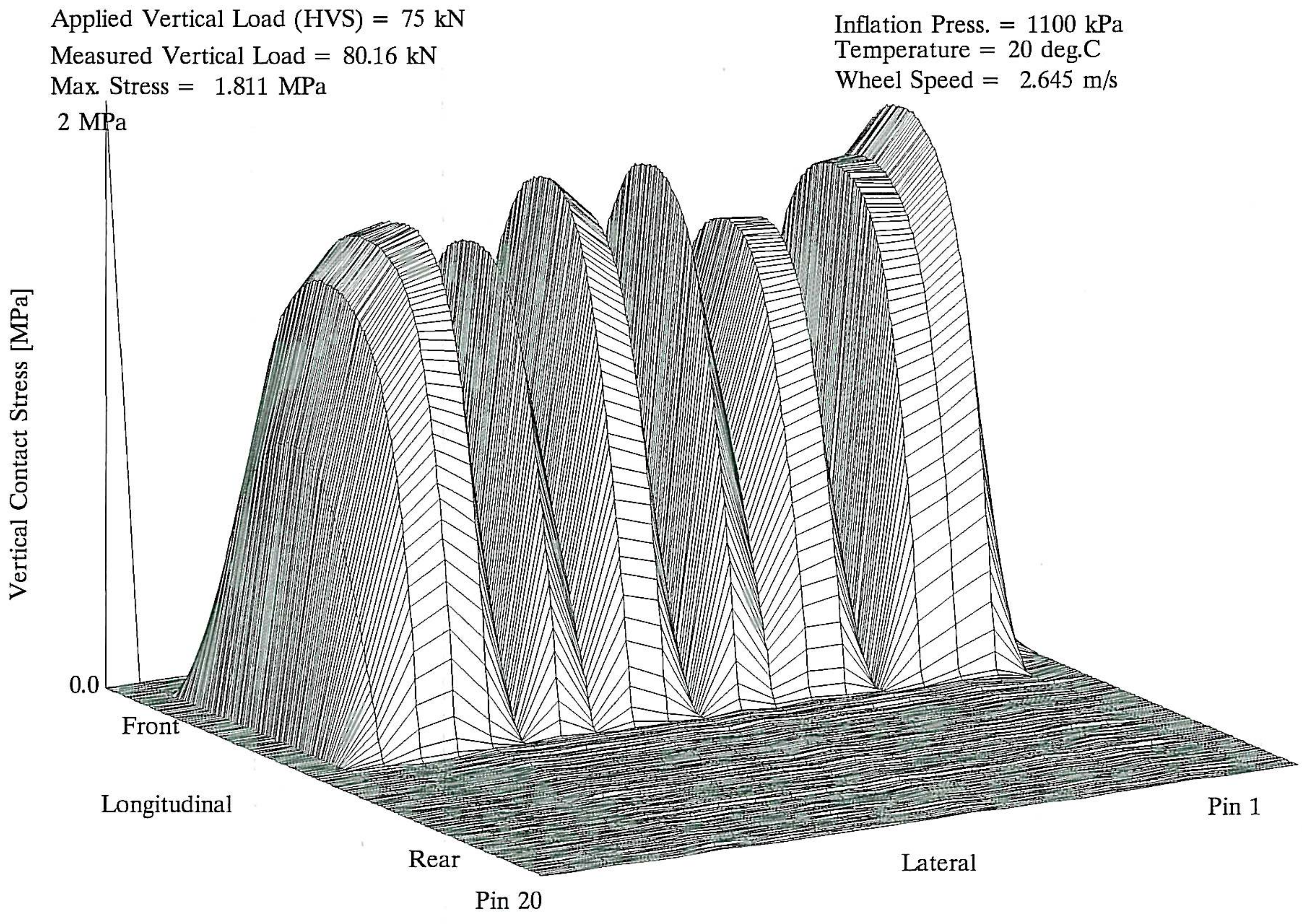
Inflation Press. = 1100 kPa
Temperature = 20 deg.C
Wheel Speed = 2.405 m/s



New Bridgestone 425/65R22.5 R164BZ

Filename : nnst15ax

FIGURE F17X



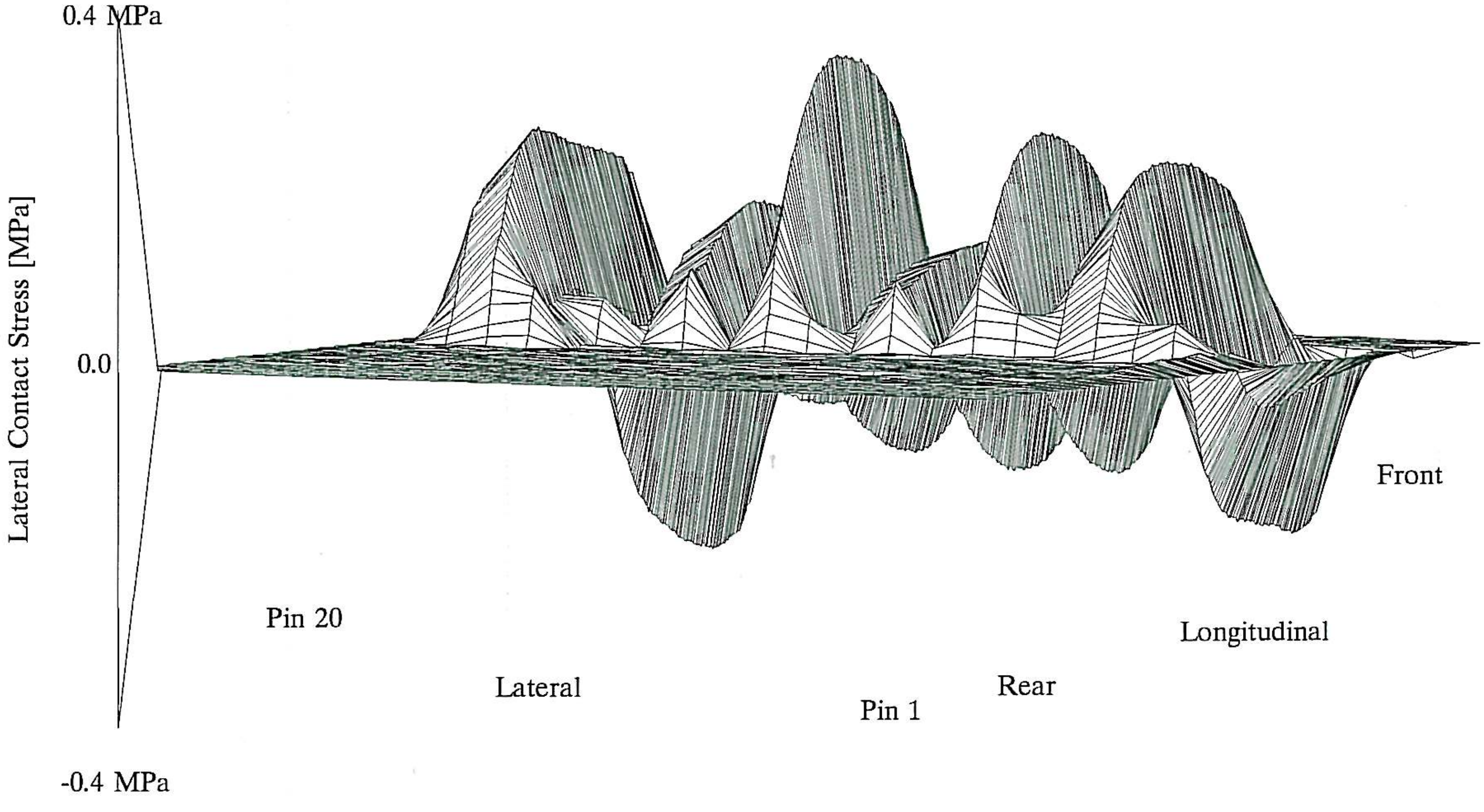
New Bridgestone 425/65R22.5 R164BZ

Filename : nnst17az

FIGURE F18Z

Applied Vertical Load (HVS) = 75 kN
Measured Lateral Load = 3.269 kN
Max. Stress = 0.3219 MPa
Min. Stress = -0.2404 MPa

Inflation Press. = 1100 kPa
Temperature = 20 deg.C
Wheel Speed = 2.645 m/s



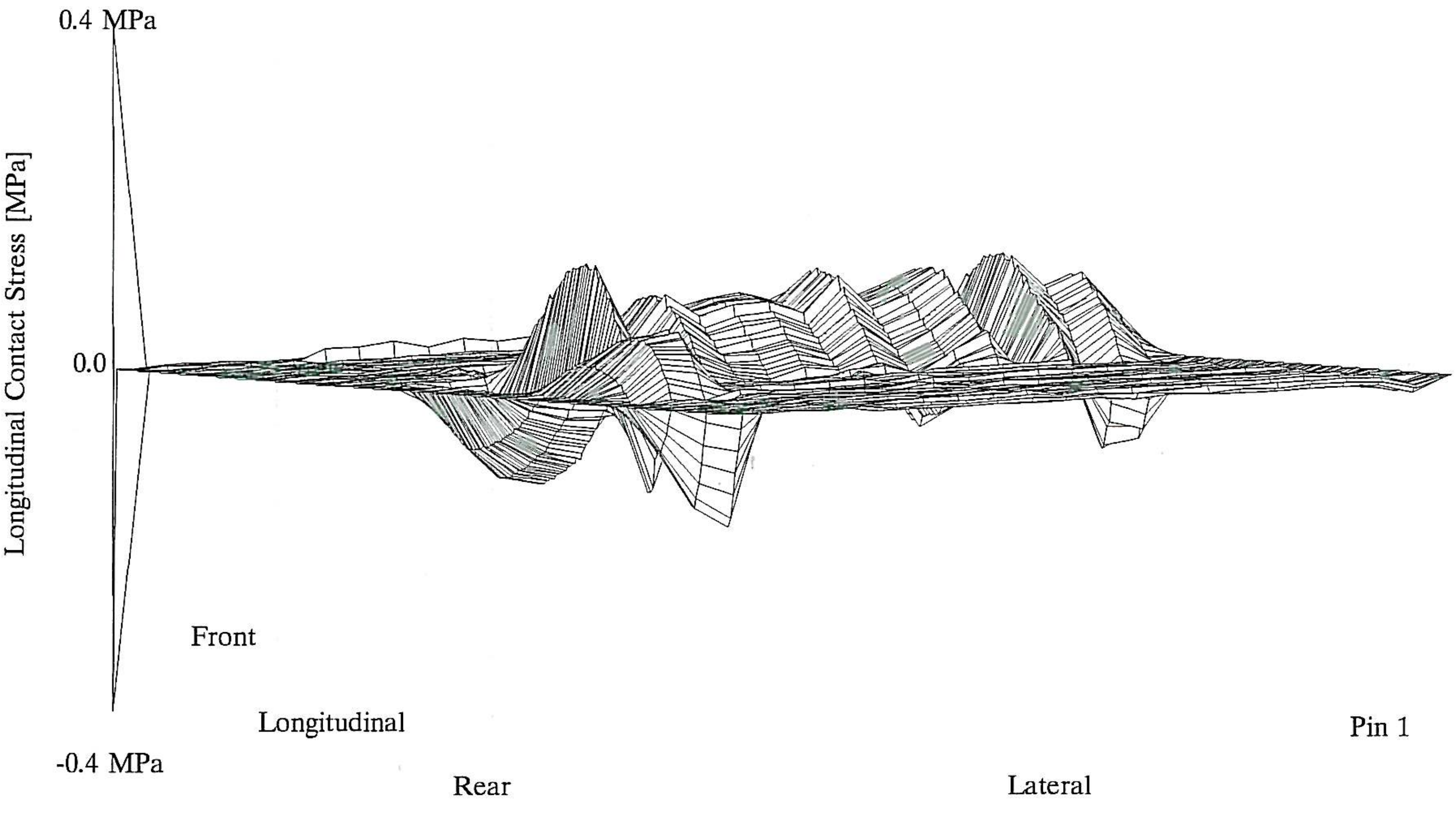
New Bridgestone 425/65R22.5 R164BZ

FIGURE F18Y

Filename : nnst17ay

Applied Vertical Load (HVS) = 75 kN
Measured Longitudinal Load = 0.7997 kN
Max. Stress = 0.1383 MPa
Min. Stress = -0.1526 MPa

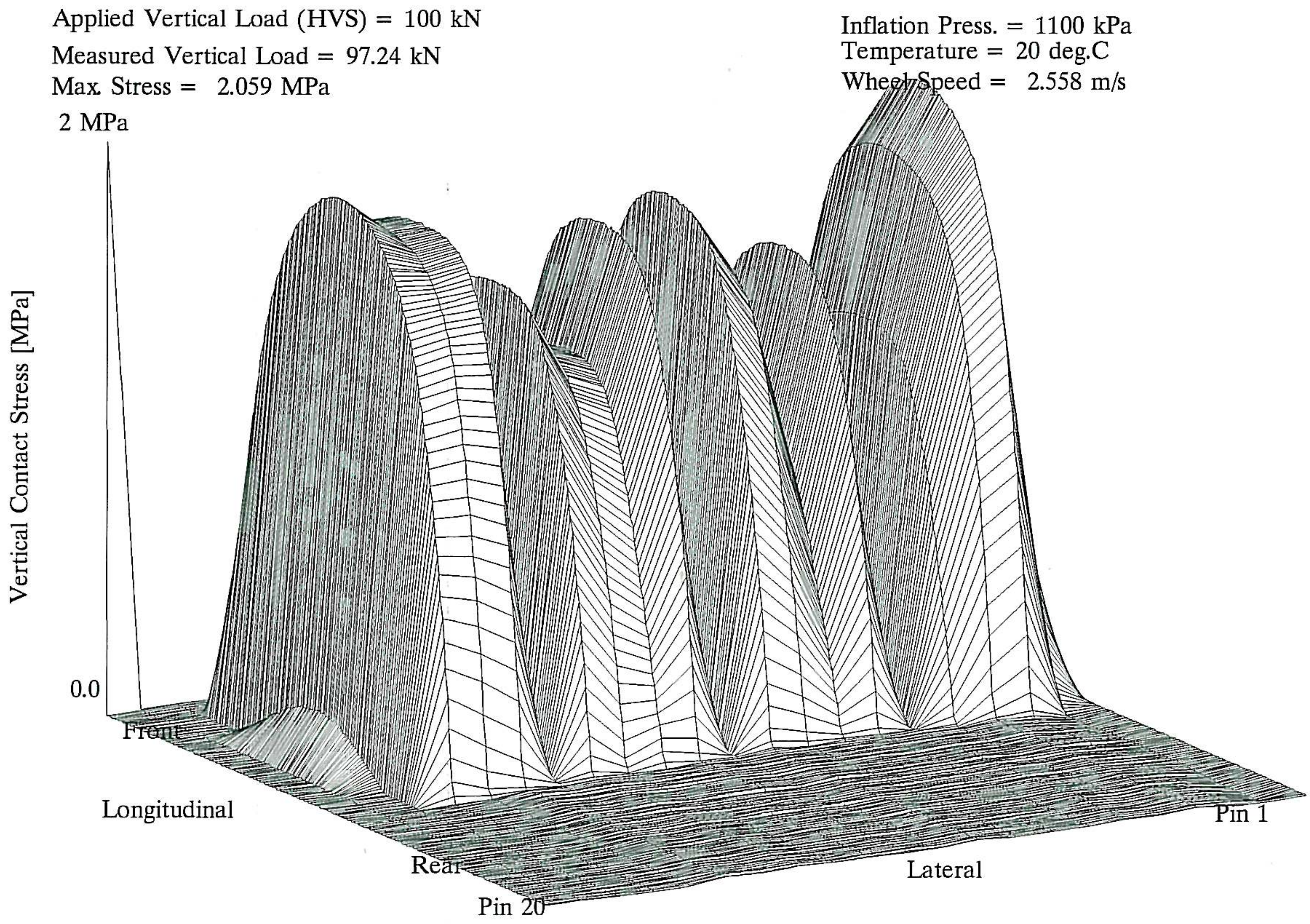
Inflation Press. = 1100 kPa
Temperature = 20 deg.C
Wheel Speed = 2.645 m/s



New Bridgestone 425/65R22.5 R164BZ

Filename : nnst17ax

FIGURE F18X



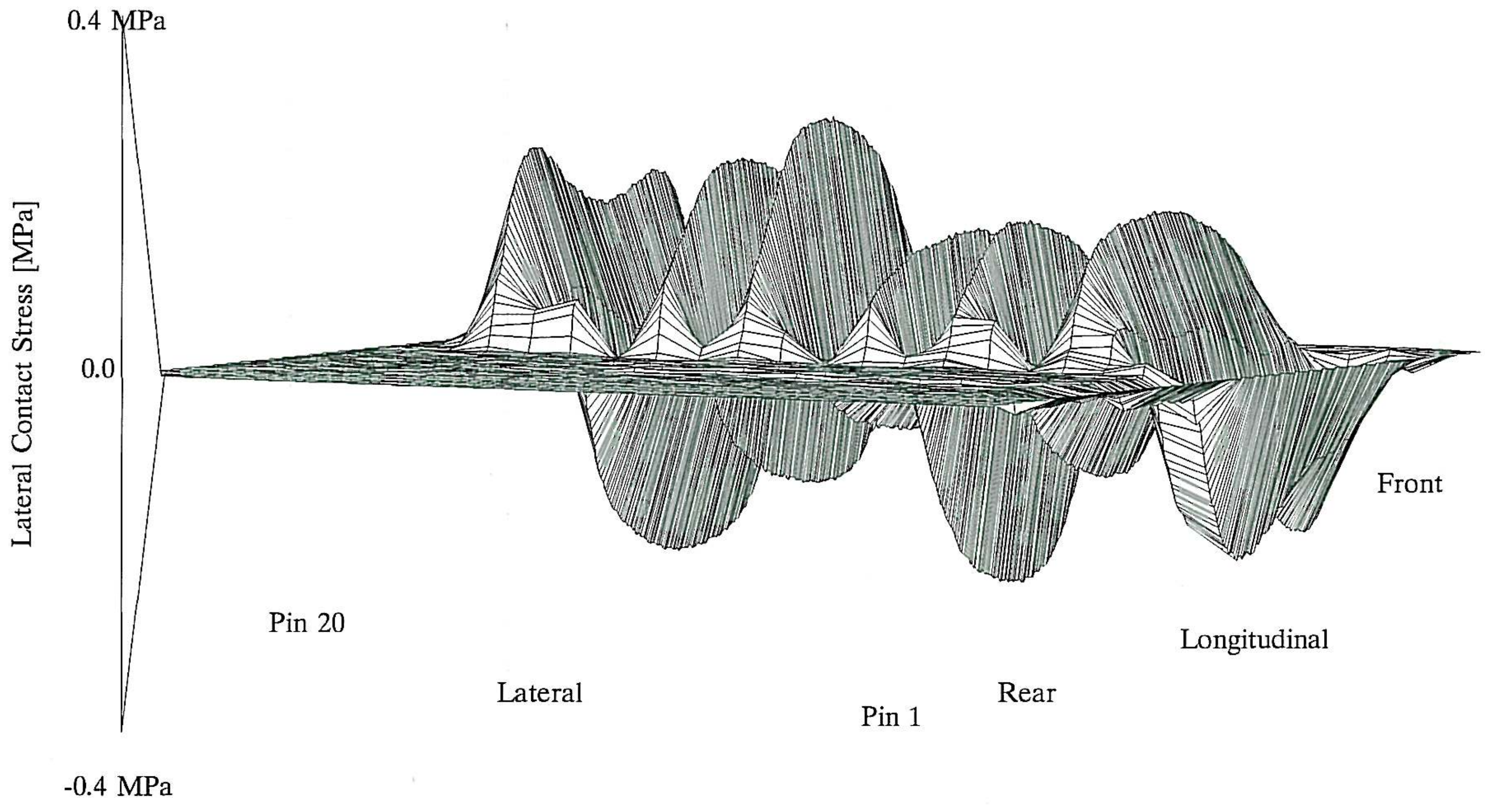
New Bridgestone 425/65R22.5 R164BZ

Filename : nnst11az

FIGURE F19Z

Applied Vertical Load (HVS) = 100 kN
Measured Lateral Load = -0.04806 kN
Max. Stress = 0.2617 MPa
Min. Stress = -0.2546 MPa

Inflation Press. = 1100 kPa
Temperature = 20 deg.C
Wheel Speed = 2.558 m/s



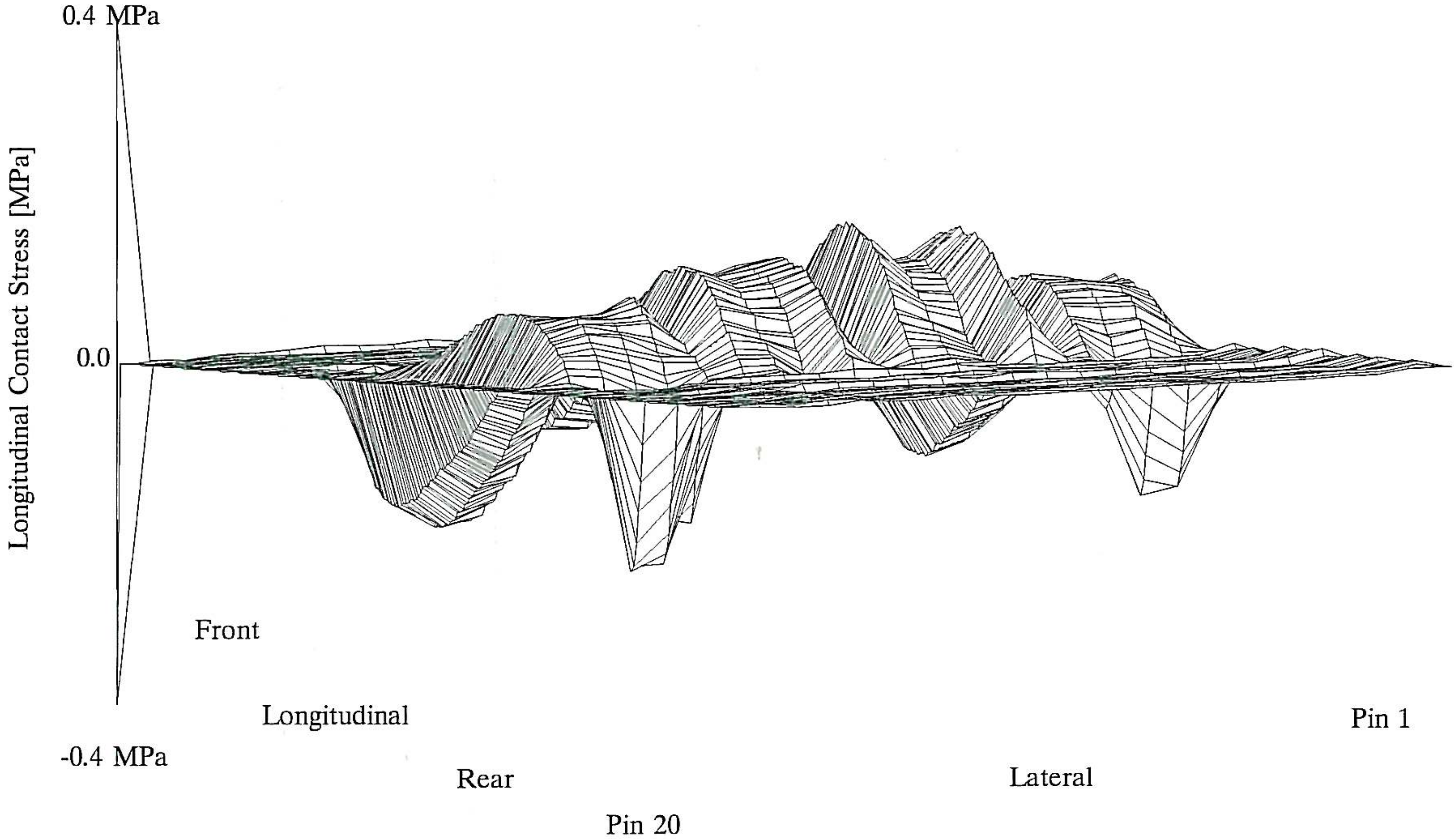
New Bridgestone 425/65R22.5 R164BZ

FIGURE F19Y

Filename : nnst11ay

Applied Vertical Load (HVS) = 100 kN
Measured Longitudinal Load = 0.1921 kN
Max. Stress = 0.1663 MPa
Min. Stress = -0.2173 MPa

Inflation Press. = 1100 kPa
Temperature = 20 deg.C
Wheel Speed = 2.558 m/s



New Bridgestone 425/65R22.5 R164BZ

FIGURE F19X

Filename : nnst11ax