

# NEXEN

Next Century

**NEXEN** for Forklift trucks and Special Vehicles

INDUSTRIAL SOLID TIRES

## INTRODUCTION OF NEXEN SOLID TIRES

	팀원	팀원	팀장	연구소장
결재				

**NEXEN** R&D CENTER

2020. 07. 15.



**NEXEN** Global Leading Company

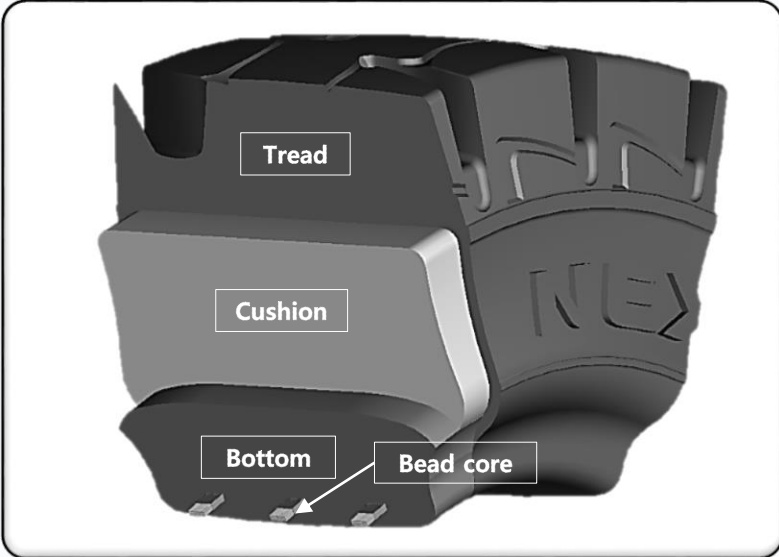

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# Part 1. Solid Tire Usage Information



# Part 1. Solid Tire Usage Information

## ■ Difference between Solid and Pneumatic Tires (Structure and Characteristics)

Category	Solid Tire	Pneumatic Tire
Components	<ul style="list-style-type: none"> <li>○ Rubber, Bead core</li> </ul>	<ul style="list-style-type: none"> <li>○ Rubber, Cord, Belt, Beadwire</li> <li>○ Air layer</li> </ul>
Advantage	<ol style="list-style-type: none"> <li>1. High load capacity</li> <li>2. Strength of puncture and breakage</li> <li>3. High stability of driver and load even in case of breakage</li> </ol>	<ol style="list-style-type: none"> <li>1. More flexible and comfortable driving</li> <li>2. More high-speed and continuous run than solid tire</li> </ol>
Weakness	<ol style="list-style-type: none"> <li>1. Thermal accumulation by internal heat → Require sufficient cooling time</li> </ol>	<ol style="list-style-type: none"> <li>1. Low load capacity compared to solid tire</li> <li>2. Disadvantage to puncture and breakage</li> <li>3. Risk of major accident if punctured and damaged</li> </ol>
Structure		

# Part 1. Solid Tire Usage Information

## ■ Possible status which can be switched from Pneumatic tires to Solid tires

- 1) In general, Solid tires have a higher load rating and can be used in harsh environments compared to Pneumatic tires.
- 2) However, unlike Pneumatic, it is difficult to use for continuous operating time and distance.  
Also, driving more than 25 km/h, and road driving should be avoided.

※ Avoid inappropriate use conditions by referring to the detailed precautions on the following page

### 3) Usages of Solid tires



Solid tire is mostly equipped and used on forklift.

Solid tire occupies 50~60% of original equipped forklift tires and it is gradually increased since solid tire has better efficiency than pneumatic tire.

#### **Manufacturing/Logistics**

Forklift(Diesel/Gas/Electronic), Reach type forklift, Tow Tractor

#### **Harbor**

Container Trailer, Reach stacker, Container Handler

#### **Airport**

Passenger Boarding Bridge, Dolly, Belt Loader

#### **Ship building, Construction**

Ship carrier, Cherry picker, Sissors lift, Excavator  
Skid loader, Sludge pot carrier, Boat Carrier

※ Not suitable for equipment that drives continuously on the road

# Part 1. Solid Tire Usage Information

## ■ Precaution for use of solid tire

1. Make sure that you have sufficient cooling time for 7 to 8 hours, with the prescribed ① load, ② speed, and ③ distance.

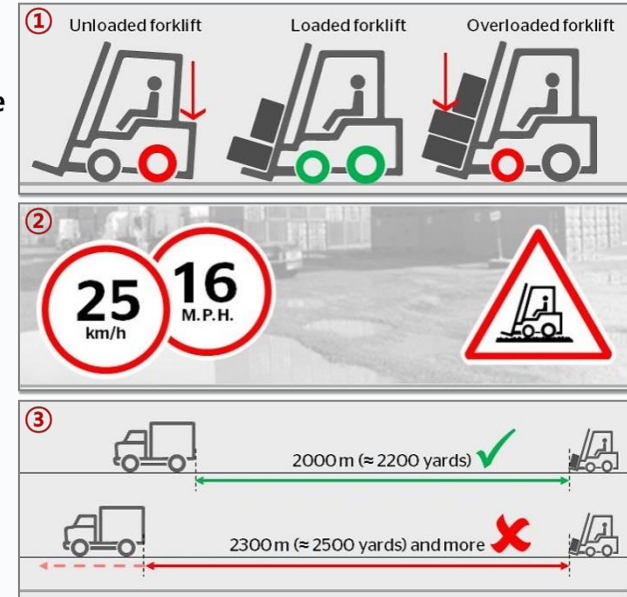
① **Load** : In case of overload, the front axis is burdened

On the other hand unload, the back spindle is burdened by counterbalance is applied.

Comply proper load compliance, it ensures designed endurance life.

② **Velocity** : Designed for speeds of up to 25 km/h or less. If be used as an unpaved road or rough road conditions such as Rails, You have to drive slow down. Otherwise, Tire life will decrease.

③ **Distance** : Solid tires have to be used within 2 km, unloaded as well as overloaded. There is a high possibility of serious heat up and deformation when over-running.



2. There should be nothing on the road that could damage the tires, and the operating habits such as sudden stops, sudden accelerations and sudden steering can cause tire damage and deteriorated quality.

3. Typical tire is used temperatures at -30°C to 50°C, Sudden change in operating temperature may damage the tire internal structure. Therefore, it is recommended to use in the workplace with constant working temperature.

4. Intermittent preheating is recommended when the tire is not used for a long time, as the tire may cause permanent deformation when not used for a long time.

# Part 1. Solid Tire Usage Information

## ■ Solid tire storage procedures

1. Solid tires should basically be stored in warehouse.
2. Should be stored in the shade without sunlight. Otherwise, may be discolored by sunlight.
3. Nexen provide products warranty for 3 years.

(This serial number can be found on the tire sidewall : This is a four digit number)

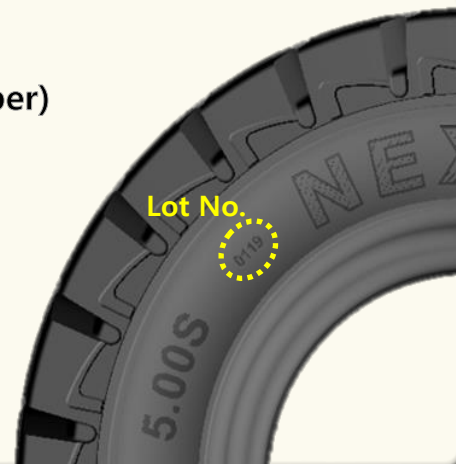
※ Lot No. : Production Date Indicator(serial number)

ex)

0119

01 : Week / 19 : Year

▶ Produced on 01th week in 2019



※ If want further information about solid tire, please visit the following website

[Website] → <https://www.nexensolidtire.com/>



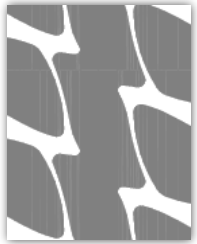
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# Part 2. NEXEN Solid Tire Introduction



## ■ Main Products

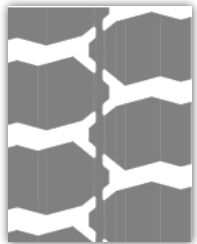


## SOLIDPRO 700

/ SOLID RESILIENT TIRES

*Ultimate Performance, SOLIDPRO 7 Series*

New pattern NP01, well-balanced performance and stylish curves.  
Enhanced groove depth & J-line.  
Ensured stability specific to transportation of heavy duty.



## ALL-PRO HP / SOLID RESILIENT TIRES

*Classic solid tire, ALLPRO HP*

Standard of solid tire, CBX pattern design enables to perform the perfect traction & brake power.  
If you are looking for tires true to the basics, ALL-PRO HP will be the best option for you.

# Part 2. NEXEN Solid Tire Introduction

## ■ Special Products



### **NEXEN** / SOLID RESILIENT TIRES

*Workable to all environment with various patterns.*

Required performance is different by working environment and application characteristics.  
NEXEN solidtire guarantees the optimized efficiency with the various patterns.



### **NEXEN POB** / SOLID PRESS-ON TIRES

*From small forklift to special usage application, NEXEN POB*

Press-on band tire (Cushion tire) is mainly mounted to small & electric forklift.  
And, it also provides various sizes for from caster to special usage application such as passenger boarding bridge.

# Part 2. NEXEN Solid Tire Introduction

## ■ Replacement Guide Line of Solid Tire

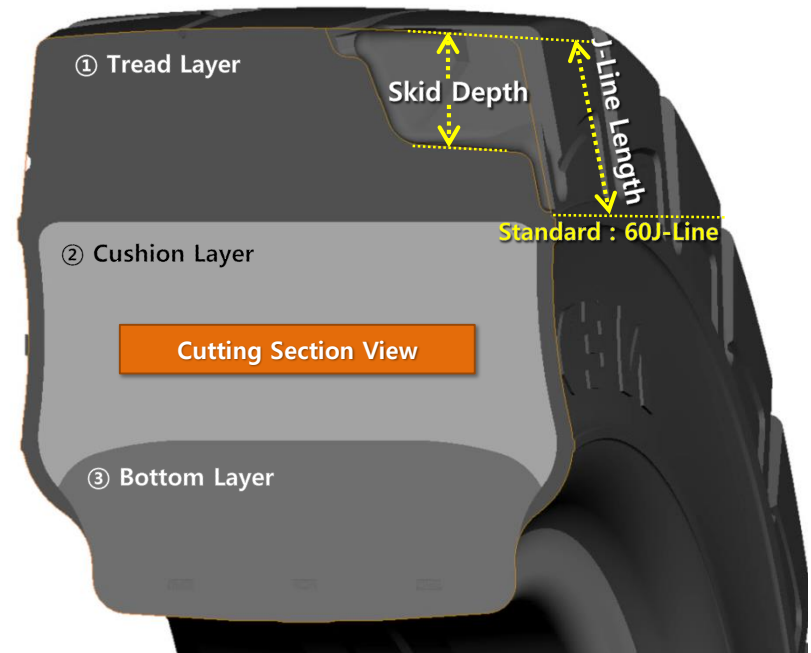
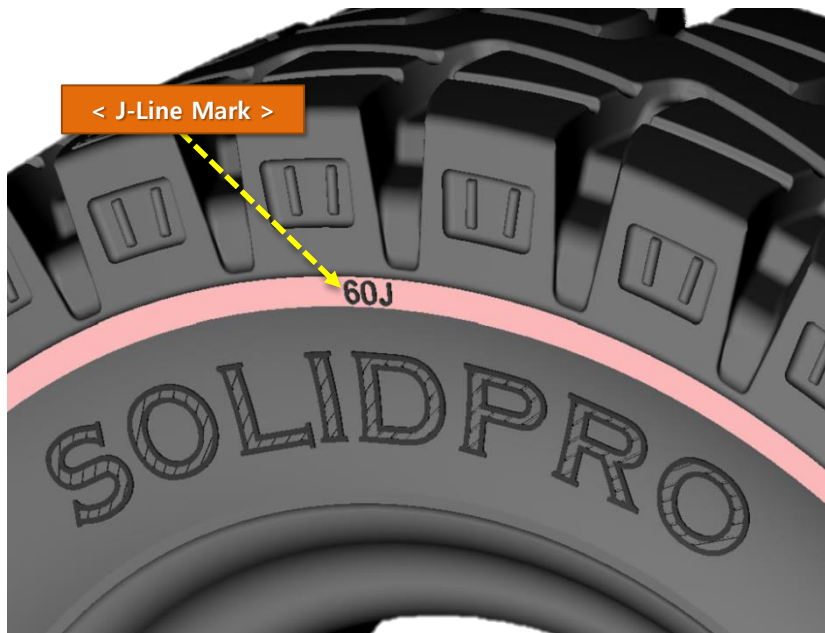
### 1. Standard of wear limit

- ① **Skid Depth** : Depth of available pattern usage.

When the pattern is completely worn out, the flat tread faces are produced.

- ② **J-Line** : Limit line of wear usage.

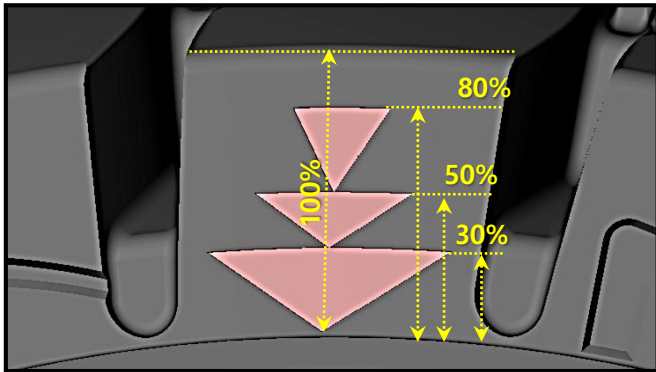
J-Line Mark(60J) is engraved on the top of a solid tire sidewall and the start of the tread.



# Part 2. NEXEN Solid Tire Introduction

## ■ Replacement Guide Line of Solid Tire

### ▶ Introduction of Wear Indicator



#### ○ Wear Indicator : Measurement indicator of tread usage

- It is applied to NP01 pattern only (SOLIDPRO 7 Series)
- 3 step wear indicator (80%, 50%, 30%)
- 1 side 2 feature : upside Country & Size



### ▶ Variation of the wear indicator due to use



100%

New Tire



80%

80% of block, from J-line to top, remained (20% WORK OUT)



50%

50% of block, from J-line to top, remained (50% WORK OUT)

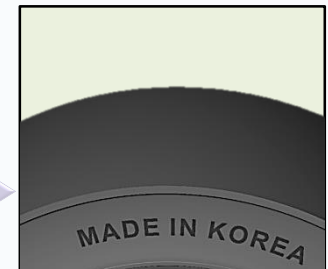


< Pattern worn out >

30%

30% of block, from J-line to top, remained (70% WORK OUT)

※ It is time to replace a worn tire by new tire or regroove until J-Line



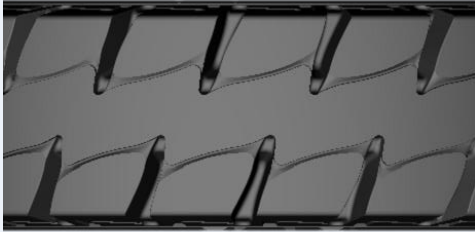
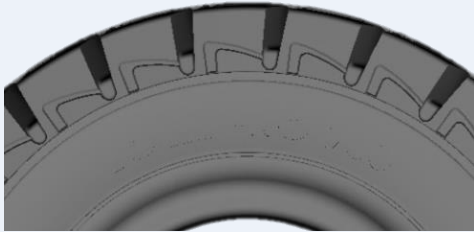

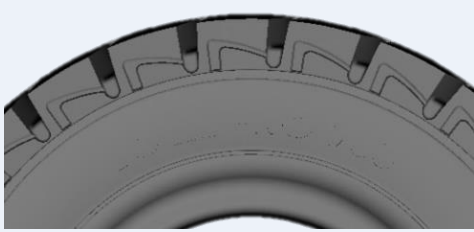

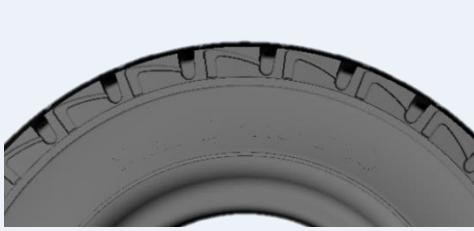
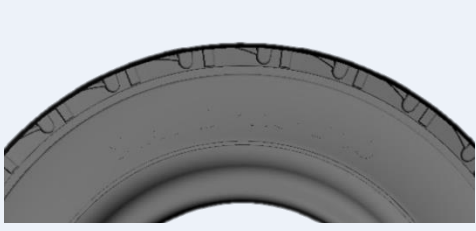
Tread worn out

Tread worn out

# Part 2. NEXEN Solid Tire Introduction

## ■ Pattern Shape according to Residual Tread Depth

### ▶ NP01 Pattern (SOLIDPRO 700)

	Tread	Block
New Tire		
80% remained (20% worn)		
50% remained (50% worn)		
30% remained (70% worn)	< Pattern worn out >	

### Additional Information



- ⊙ When using about 70% of Tread Depth, the pattern is worn out.
- ⊙ If pattern performance is required, We recommend you to change the tire.
- ⊙ If pattern performance is not required, it will continue to be available until J-Line. (If cushion rubber protrudes before J-line according to the uneven wear, replace the tire.)

# Part 2. NEXEN Solid Tire Introduction

## ■ Pattern Shape according to Residual Tread Depth

### ▶ CBX Pattern (ALL-PRO HP)

	Tread	Block
New Tire		
80% remained (20% worn)		
50% remained (50% worn)		
30% remained (70% worn)	< Pattern worn out >	

### Additional Information



- ⊙ When using about 70% of Tread Depth, the pattern is worn out.
- ⊙ If pattern performance is required, We recommend you to change the tire.
- ⊙ If pattern performance is not required, it will continue to be available until J-Line. (If cushion rubber protrudes before J-line according to the uneven wear, replace the tire.)

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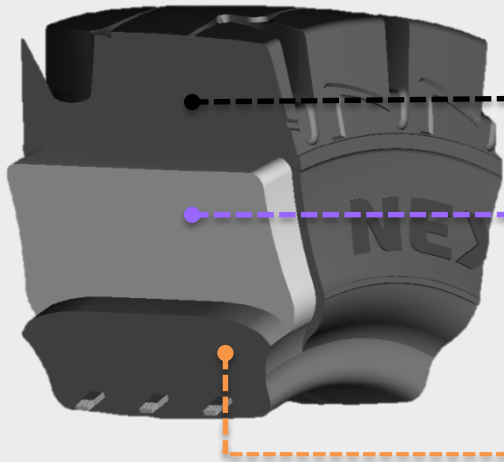
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# Part 3. SOLIDPRO 700 Design Technology



# Part 3. SOLIDPRO 700 Design Technology

## ■ SOLIDPRO 700



### **Tread Compound**

- Proven quality (High Abrasion, Low Heat Build up, High elasticity, Low R.R)

### **Cushion Compound**

- High elasticity compound for Anti-Shock & Anti- vibration  
( Elasticity & Low Heat Build Up )

### **Bottom Compound**

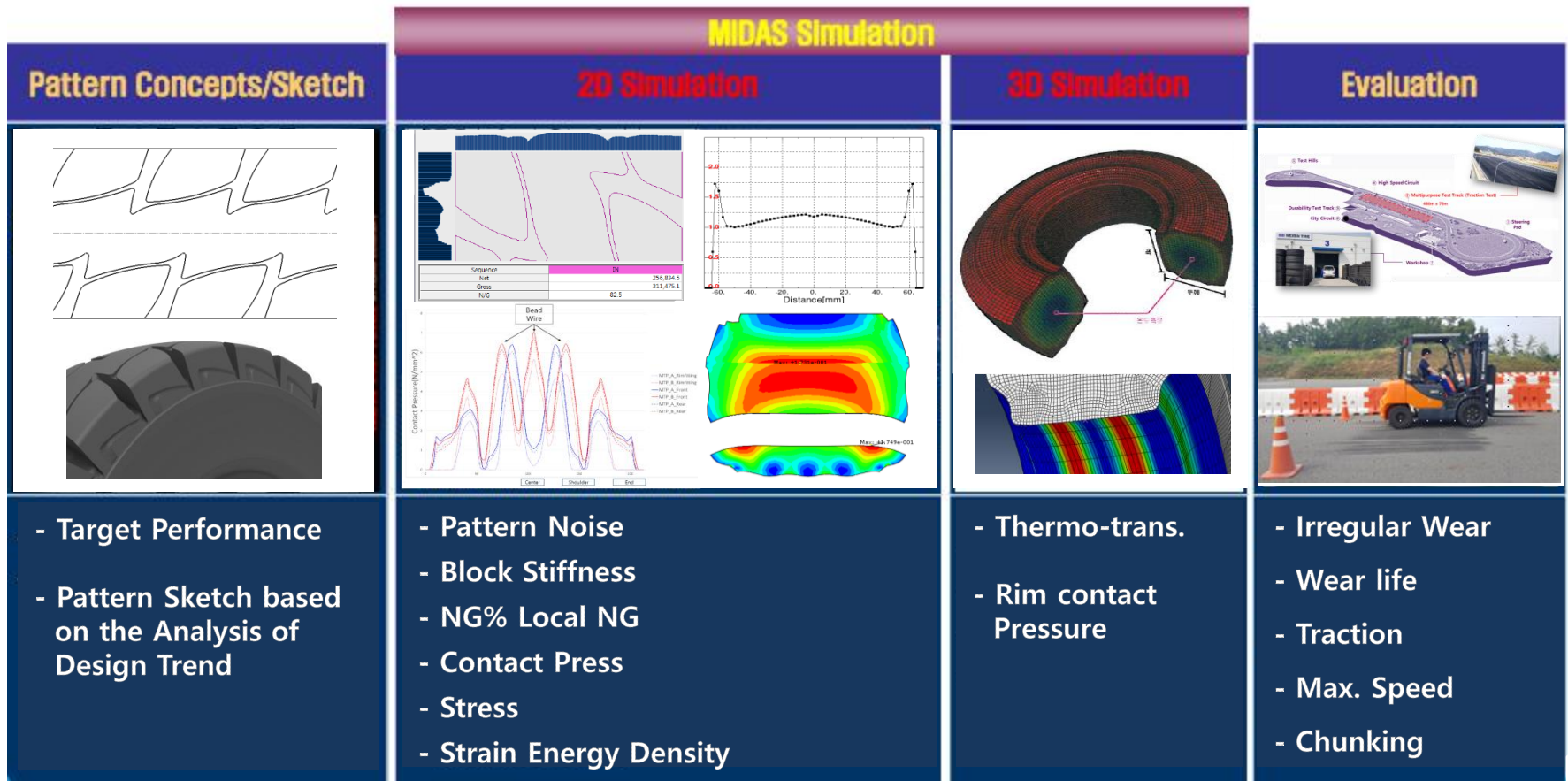
- Bottom Compound for continuous repetitive motion  
(Rigidity, Adhesion & Low Heat Build Up)

# Part 3. SOLIDPRO 700 Design Technology

## Advanced engineering for optimum design using MIDAS

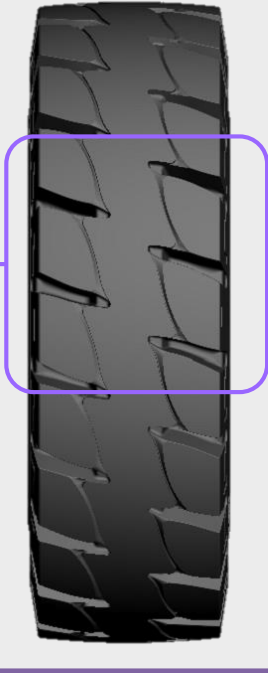
MIDAS ( the Most Intelligence Design Automation System ) : Nexens own Design Tool

→ The simulation tools for **well-balanced pattern performance**



# Part 3. SOLIDPRO 700 Design Technology

## ■ Appearance



### 1) Strong but polished look

Large block, deep groove → **strong**,  
tread pattern reminds customer of 'n' of Nexen  
→ **polished feeling**

### 2) Balanced performance

endurance, wear-out, noise, vibration and  
fuel ratio were set for optimized performance



### 3) Elegant Sidewall Decoration

- ① Decoration are in harmony with the tread pattern shape.
- ② Stylish knurling design of Sidewall



### 4) Wear Indicator

- 3 step wear indicator (80%, 50%, 30%)
- 1 side 2 feature : upside Country & Size

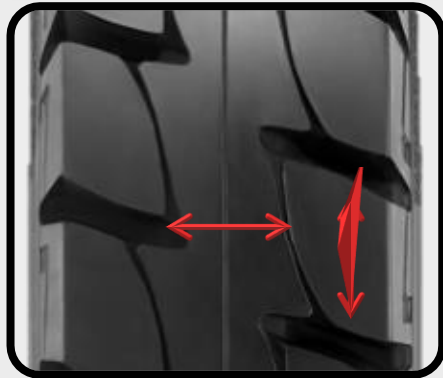


# Part 3. SOLIDPRO 700 Design Technology

## Applied technology by performance

### Wear Performance

#### OCAS



#### Description

**OCAS**  
(Optimized Contact Area System)

Increase Block rigidity

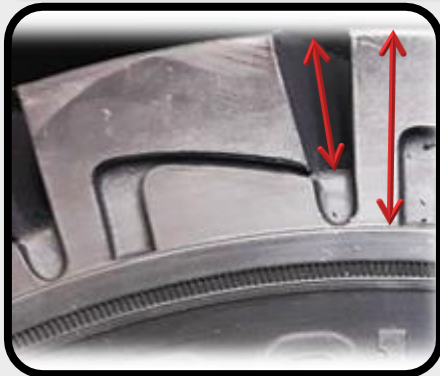
Increase Wear Resistance

### Max. Speed

#### Factor

Max. Speed Influence factor	Rolling Resistance	Traction
Compound	elasticity ↑	Grip ↑
Construction, Pattern	Layer, Profile, Weight, etc..	<b>Contact Area ↑</b>

#### OGDS



#### Description

**OGDS**  
(Optimized Groove Depth System)

Increase Life span

#### OCAS



#### Description

**OCAS**  
(Optimized Contact Area System)

Increase Traction

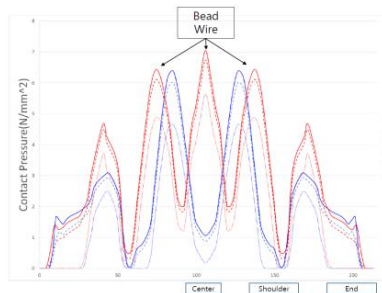
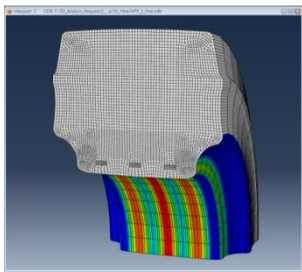
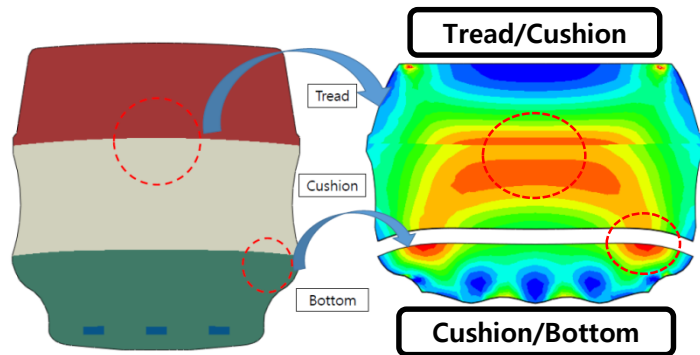
Increase Max. Speed

# Part 3. SOLIDPRO 700 Design Technology

## Applied technology by performance

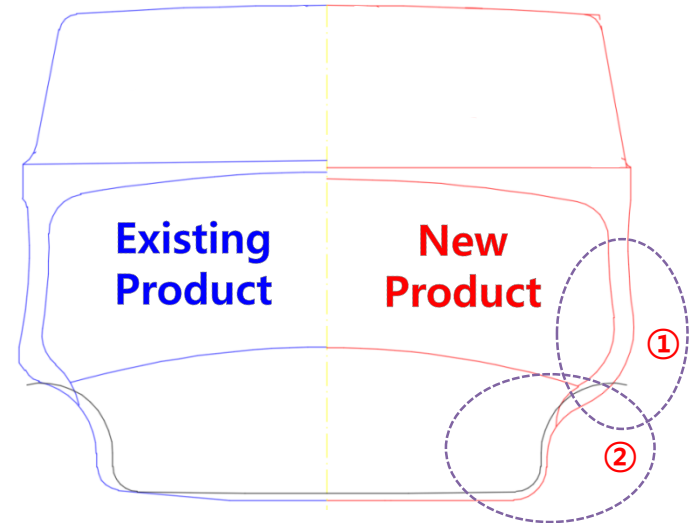
### Endurance

#### FEM Simulation



- Using FEM Simulation Profile shape design is applied to improve durability and pressure for grasp to rim.

#### OPDS



**OPDS**  
(Optimized Profile Design System)

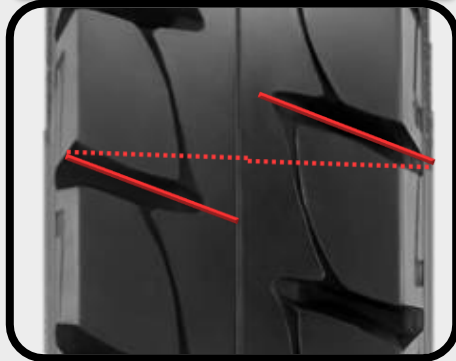
- ① Increase Bottom parts durability increase
- ② Increase durability and pressure for grasp to rim

# Part 3. SOLIDPRO 700 Design Technology

## ■ Applied technology by performance

### Vibration

#### OPAS



#### Description

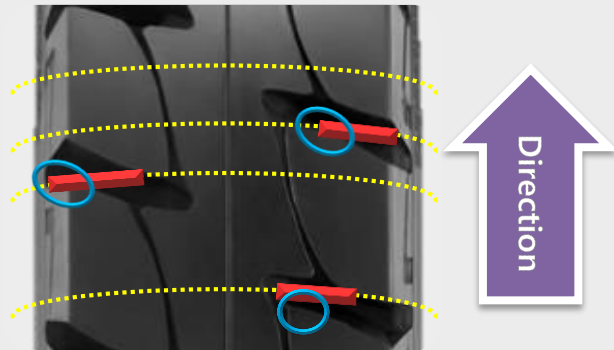
**OPAS**  
(Optimized Pattern Groove Angle System)

Minimize Bounce  
Minimize Edge Impact

### Chunking

#### Causes


- 1) Abnormal wear due to distortion of block on the road with high coefficient of friction
- 2) Block Crush phenomenon with chip&cut due to weak stiffness



#### Leading Edge

(The area where the tire contact the road surface at the moment of grounding)

 Void area at Leading Edge

 Edge Impact area at Leading Edge

#### OBRS

#### Description

**OBSS**  
(Optimized Block Ratio System)

Increase Block rigidity

Improve Block crush phenomenon

Improve Chunking phenomenon





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# Part 4. Performance Comparison



# Part 4. Performance Comparison

## Performance Comparison of Premium Black Tire

Comparative Indicator

Comparison Index		Category	CONTINENTAL	NEXEN	
			SC20	SOLIDPRO 700	ALL-PRO HP
<p>Endurance</p> <p>150</p> <p>100</p> <p>50</p> <p>0</p> <p>Rolling Resistance</p> <p>Heel &amp; Toe</p> <p>Wear Life</p> <p>Vibration</p> <p>● SC20   ■ SOLIDPRO 700   ▲ ALL-PRO HP</p>	Endurance	100	100	95	
	Rolling Resistance	100	100	100	
	Vibration	100	110	95	
	Wear Life	Skid Depth	100	120	100
		J-Line	100	110	100
	Heel & Toe		Standard (100)	Highly Superiority (110)	Standard (100)

# Part 4. Performance Comparison

## Performance Comparison of Premium Non-Marking Tire

Comparative Indicator

Comparison Index		Category	NEXEN	CONTINENTAL	CAMSO	TRELLEBORG
			SOLIDPRO 700	SC20	MAGNUM	ELITE XP
	Endurance	100	100	90	95	
	Rolling Resistance	100	105	95	105	
	Wear Life	Skid Depth	100	70	70	70
		J-Line	100	80	85	85
	Chip & Cut	Highly Superiority (100)	Highly Superiority (100)	Standard (80)	Standard (80)	



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# Part 5. NEXEN Solid Tire Test Methods



# Part 5. NEXEN Solid Tire Test Methods

## Test Methods

### LAB Test



1. ELONGATION
2. TENSILE STRENGTH
3. ABRASION
4. AGING

### Indoor Driving Test



1. DIMENSION CHECK
2. CONTACT AREA & PRESSURE AND DEFLECTION TEST
3. ENDURANCE & ROLLING RESISTANCE TEST

### Outdoor Test



1. CCI TEST
2. SERVICE LIFE TEST
3. MAX SPEED TEST

NEXEN

NEXEN

NEXEN



## ■ Test Methods

### 2. Driving Test Method

► Purpose of Indoor Driving Tester : Endurance, Rolling Resistance, Vibration, Static Characteristic

1) Endurance : Drive on the Tester until the tire is destroyed

- ① Evaluation Condition : Temperature 20~25°C, Humidity 45~85%
- ② Evaluation Velocity : 6 km/h
- ③ Evaluation Load : 100%~140% of the prescribed load(Standard ETRTO) , 10% load increase at 30 min intervals

Speed (km/h)	Load (kg)	Running time (min)	Remark
6km/h	100% (5,850kg)	40	Warm up
	110% (6,435kg)	30	-
	120% (7,020kg)	30	-
	130% (7,605kg)	30	-
	140% (8,190kg)	30	-
	150% (8,775kg)	30	-
	160% (9,360kg)	30	-
	Maintain 160%	30 min intervals	-

**Test Condition : Speed / Load / Time**  
 (There is no internationally defined evaluation method, NEXEN self-assessment method)

2) Rolling Resistance : Calculate the rolling resistance using Torque, which acts on the loader through the Tire, in the driving drum

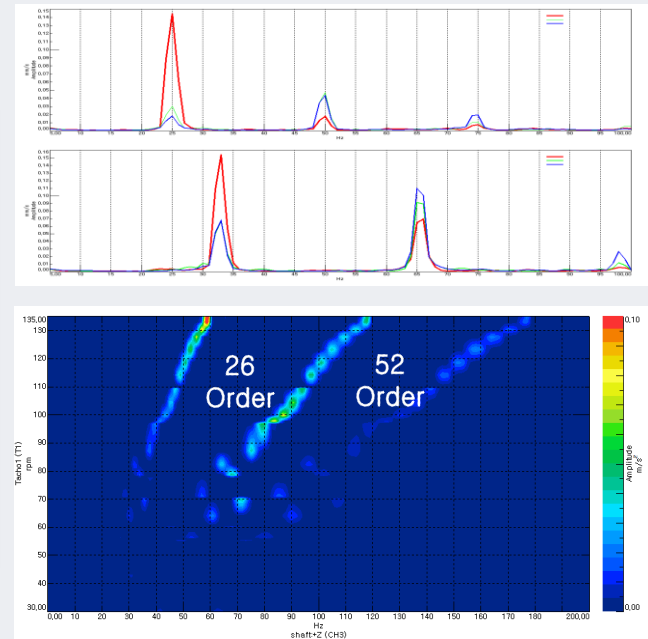
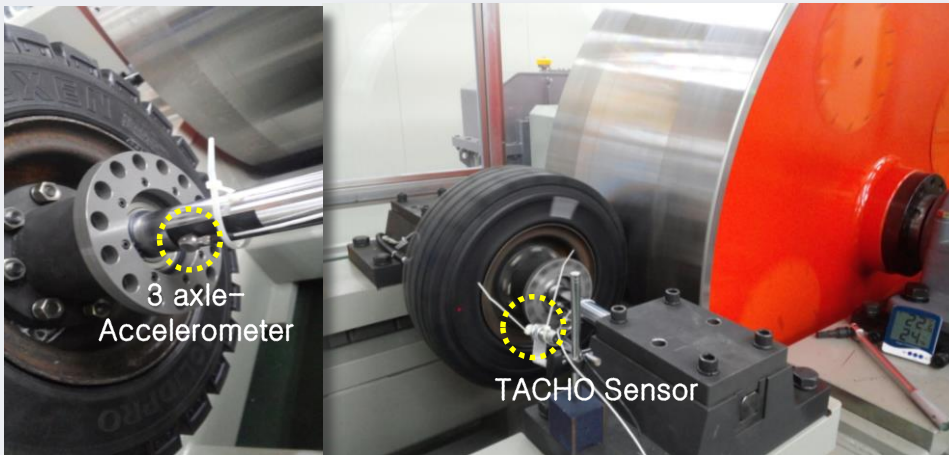
# Part 5. NEXEN Solid Tire Test Methods

## ■ Test Methods

### 2. Driving Test Method

3) Vibration : Collects and analyzes electrical signals to the acceleration sensor via the Tires when driving

- ① Evaluation Condition: Mounting a driving tester, specification 6.50-10 / load 100% (2,340 kg) / speed 6 km/h
- ② Evaluation Equipment : National Instrument DAQ (Hardware) / LabVIEW (Software)
- ③ Analysis Method : 3-axis acceleration sensor signal collection
  - Convert/Save to digital signal from DAQ
  - Spectroscopic analysis on PC
- ④ Amplitude Scale : 1 to 80 Hz interval [mm/sec RMS]



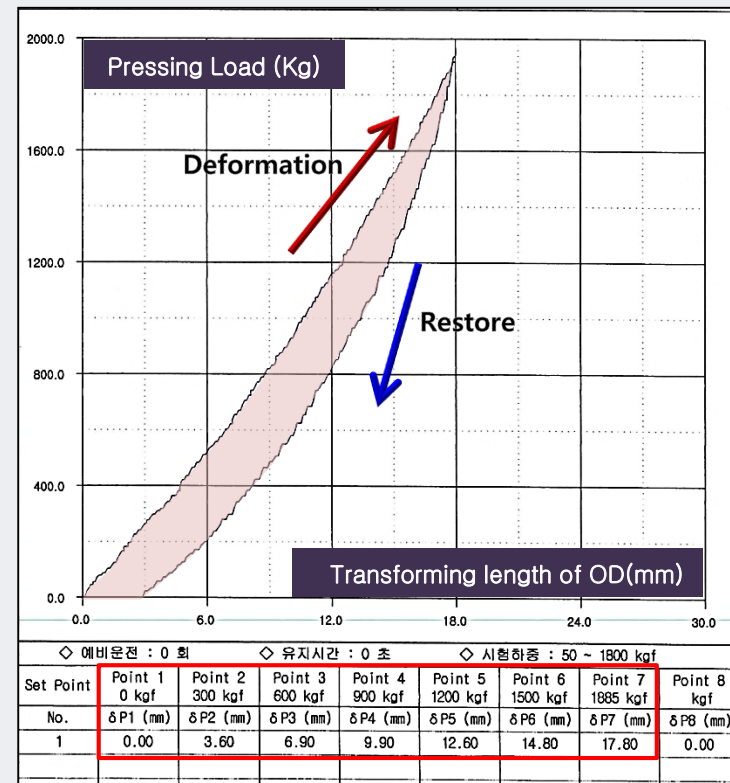
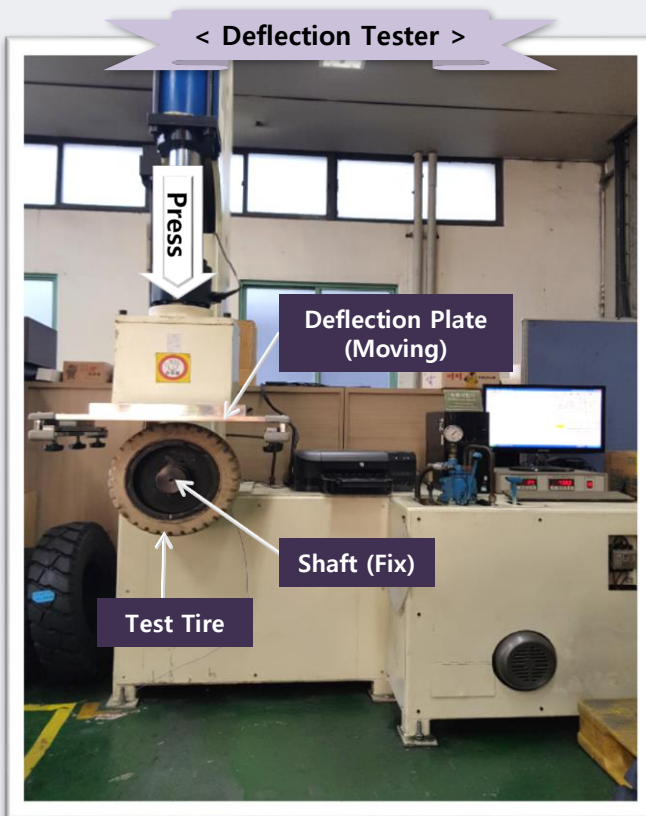
# Part 5. NEXEN Solid Tire Test Methods

## Test Methods

### 3. Static Characteristic Test

► Static Characteristic : Measure vertical deformation occurring in the tire after loading it on a fixed tire

① Deflection : 0% to 100% (load can be changed if necessary)



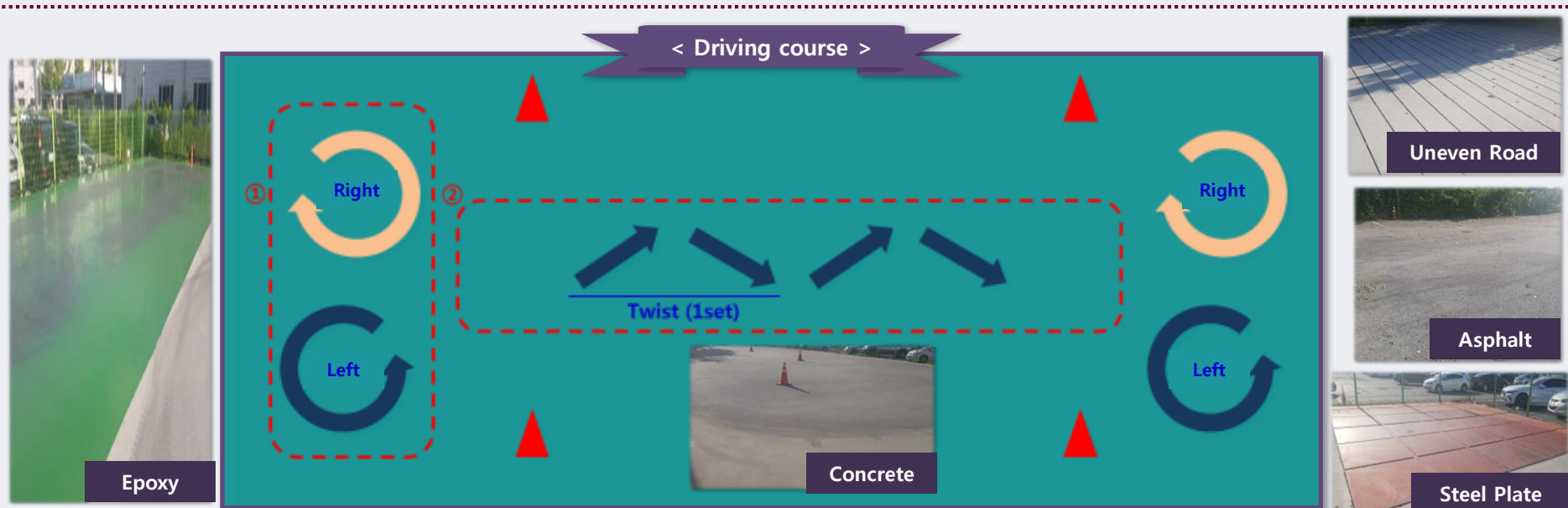
② Dimension : Using measuring tools, check the specifications, weight, appearance, etc. of the tire

# Part 5. NEXEN Solid Tire Test Methods

## ■ Test Methods

### 4. Vehicle Test In Proving Ground

- ▶ Evaluation of wear patterns through actual driving in the self-evaluation site that implements the actual use
  - ① Evaluation surface : Concrete, Asphalt, Urethane, Steel plates, Uneven road [Nexen Proving Ground]
  - ② Evaluation speed : 3 to 8 km/h
  - ③ Evaluation Load : No-Loaded Assessment (Rear Wheel-Oriented Acceleration Test)
  - ④ Evaluation Vehicle : 3.0 ton Diesel Forklift (Tire Size : 8.15-15, 6.50-10)  
3.5 ton Electric Forklift (Tire Size : 23X10-12, 18X7-8)
  - ⑤ Evaluation Method : The basic driving course runs continuously for about 8 hours a day  
(Some conditions are changed if necessary)



# Part 5. NEXEN Solid Tire Test Methods

## Test Methods

### 5. Chunking Test

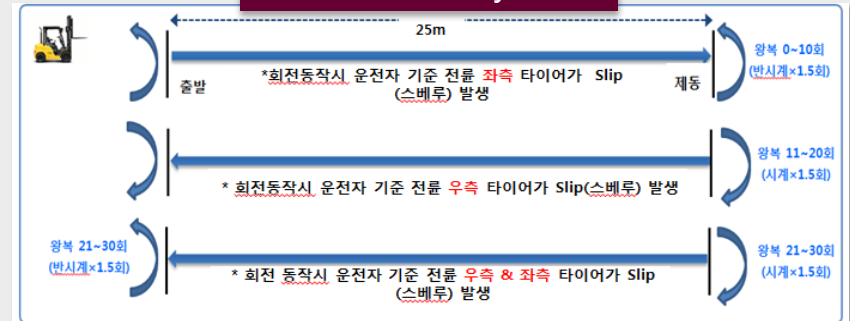
#### Test Method

##### ▶ CCI Method

(30 times / 1 Cycle × 4 Cycle = 120 times)

※ This is a self-assessment result and it is the evaluation method that induces chunking by force, so it may be different from Field usage conditions.

#### CCI Method 1Cycle



### 6. Max-Speed Test

#### Test Method

1) Evaluation stage: In a straight line segment of a total length of 100 m

"Acceleration → Maintains the maximum speed → Deceleration"

2) Data acquisition : We gather the entire speed history from the acceleration section to the deceleration section

※ break-down : 500m straight running

