

## **Developing FE-TIRE Model for Road Noise Simulation**

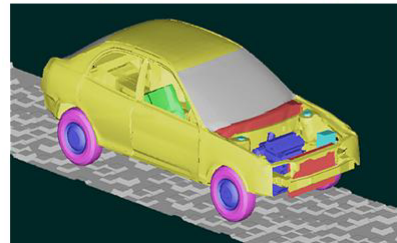
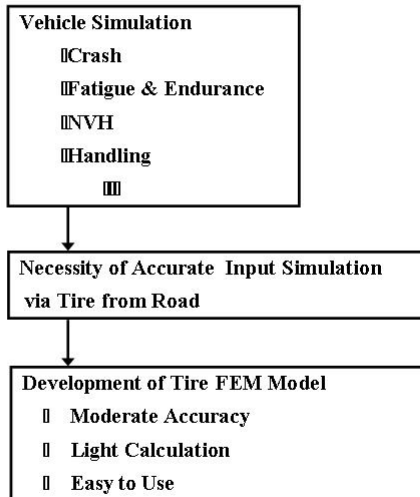
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### Concept of Virtual-Digi-Tire

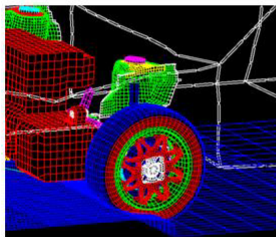
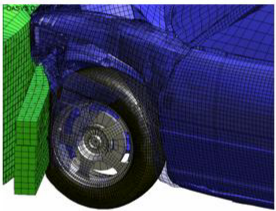
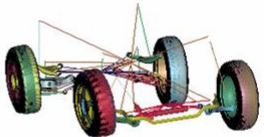


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### Current Virtual-Digi-Tire

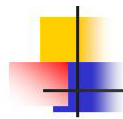


Large Impact	Crash	Severe Cornering
		
<p><b>Developed &amp; Sale by JRI &amp; SRI</b></p>		<p><b>Developed by Nissan, JRI &amp; SRI Presented at 2003</b></p>

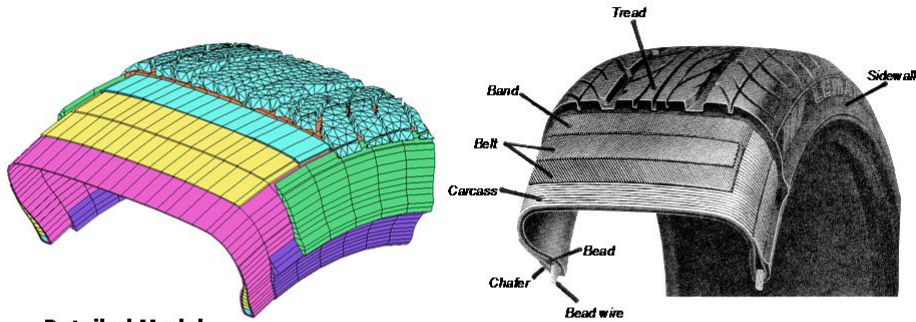
➡ Evolution for other properties



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## Tire Construction & Modeling



**Detailed Model**

: about 100 thousands elements

Large Calculation

- 4 Tire Models & Vehicle Model
- Unable Calculation for Daily Work



Development of  
Simplified Tire Model



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## Purpose & Merit of RN





### ||PURPOSE

- ||RN(Road Noise) : booming noise below 500HZ at slightly rough road
- road-tire-vehicle → matching of tire and vehicle is important
- vehicle development considering tire effect is important →

### CAE

||Comparing of tire models used for NV simulation

Modal model	Explicit model
	
NV mechanism is clear.   Boundary condition is difficult.	NV mechanism is not clear.   Boundary condition is clear.

→ Trial of using explicit model

→ Using LS-DYNA



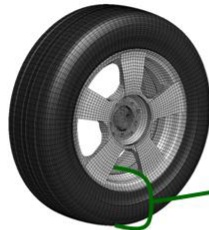
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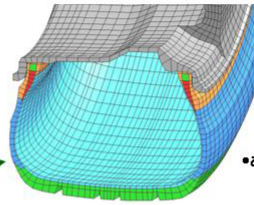
### Tire Model for RN Analysis



tire : 195/65R15  
wheel : 6.5JJ×15

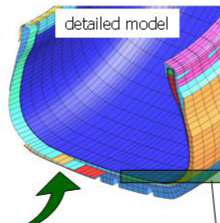
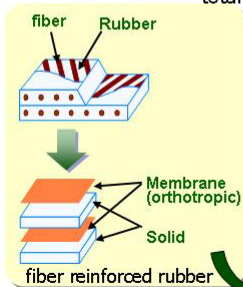


total view

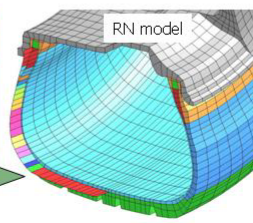


•about 36,000 elements

cross section of tire model



layered elements



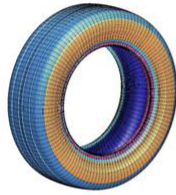


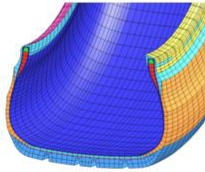
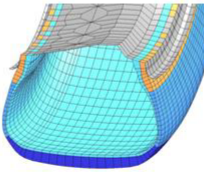
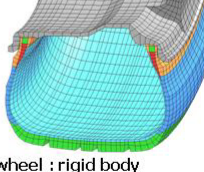
modeled by one layer element

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### Tire Model for RN Analysis



Detailed Model	Large Impact Model	RN Model
		
		
About 72,000 elements	About 24,000 elements	About 36,000 elements

wheel : rigid body

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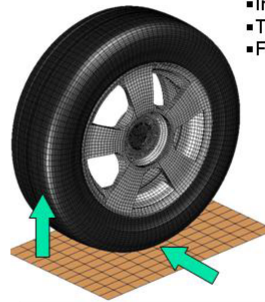
### Verification of RN Tire Model : Stiffness



#### Experiment



#### Boundary Condition



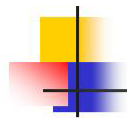
- Inner Pressure : 200kPa
- Tire Axis : Fixed
- Friction Co-efficient : 0.9

**Vertical Stiffness**  
 1.inflate  
 2.vertical movement of plate

**Lateral Stiffness**  
 1.inflate  
 2.450kgf vertical load  
 3.lateral movement of plate



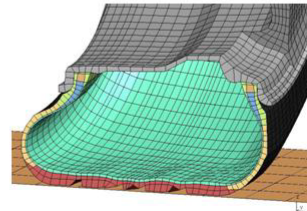
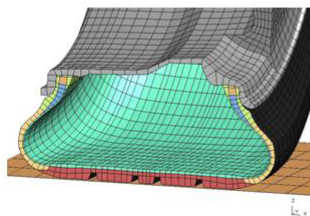
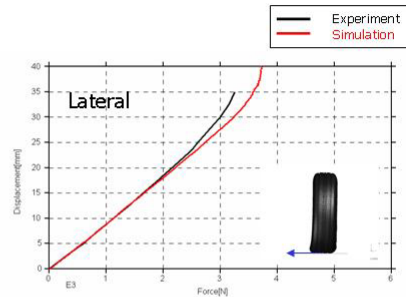
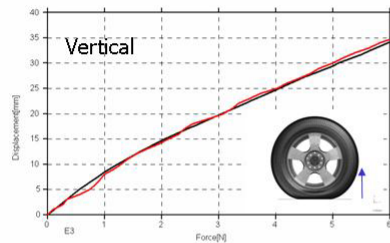
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### Verification of RN Tire Model : Stiffness



#### Simulation Result



Tire stiffness : Good correlation between simulation and experiment

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**Verification of RN Tire Model : Cleat Impact**



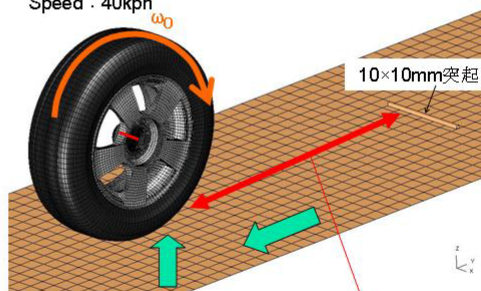
Experiment



Boundary Condition

Inner Pressure : 200kPa  
 Load : 450 k g f  
 Tire Axis : Fixed+Joint  
 Friction Coefficient : 0.9  
 Speed : 40kph

- ① Initial angle velocity
- ② Inflate
- ③ Road Movement



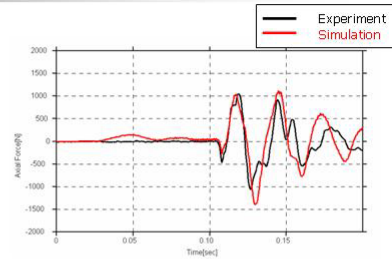
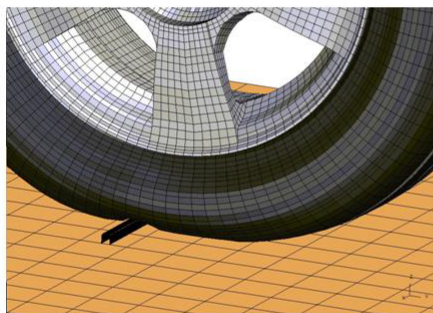
Impact timing is after 450kgf load.



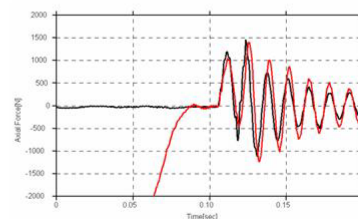
**Verification of RN Tire Model : Cleat Impact**



Simulation Result



Longitudinal force



Vertical force

① Cleat Impact : Good correlation between simulation and experiment





Verification of RN Tire Model : RN Road



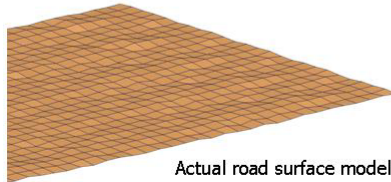
Experiment



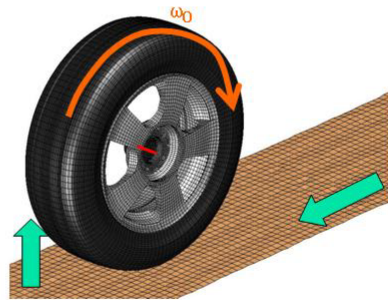
Boundary Condition

Inner Pressure : 200kPa  
 Load : 450 k g f  
 Tire Axis : Fixed+Joint  
 Friction Co-efficient : 0.9  
 Speed : 40 ~ 50kph

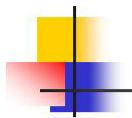
- ① Initial Angle Velocity
- ② Inflate
- ③ Road Movement



Actual road surface model



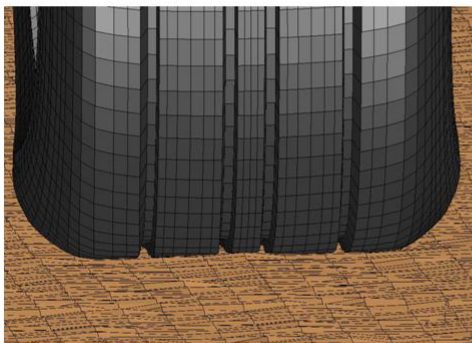
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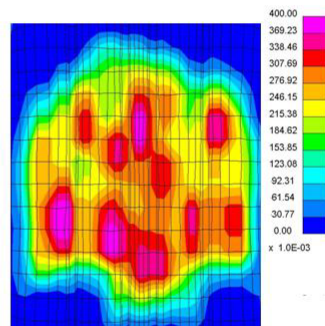
Verification of RN Tire Model : RN Road



Simulation Result



Tire Contact Pressure Distribution



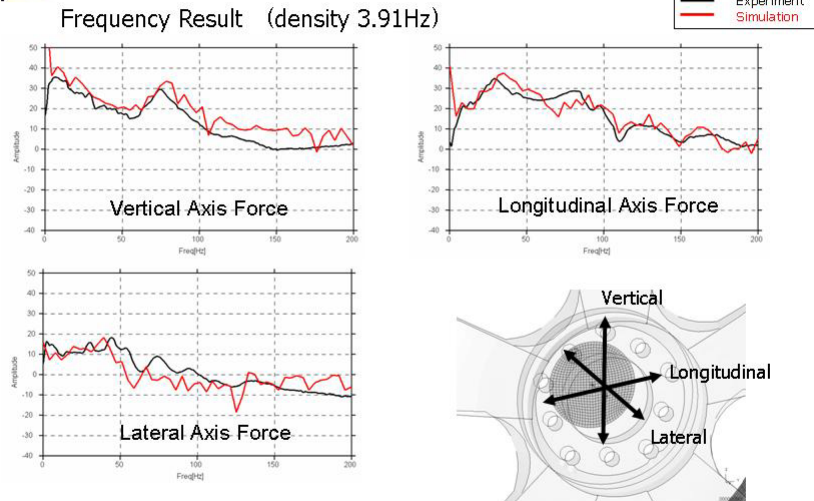
↑ Uneven contact pressure because of road roughness



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Verification of RN Tire Model : RN Road



IRN Road : Good correlation between simulation and experiment



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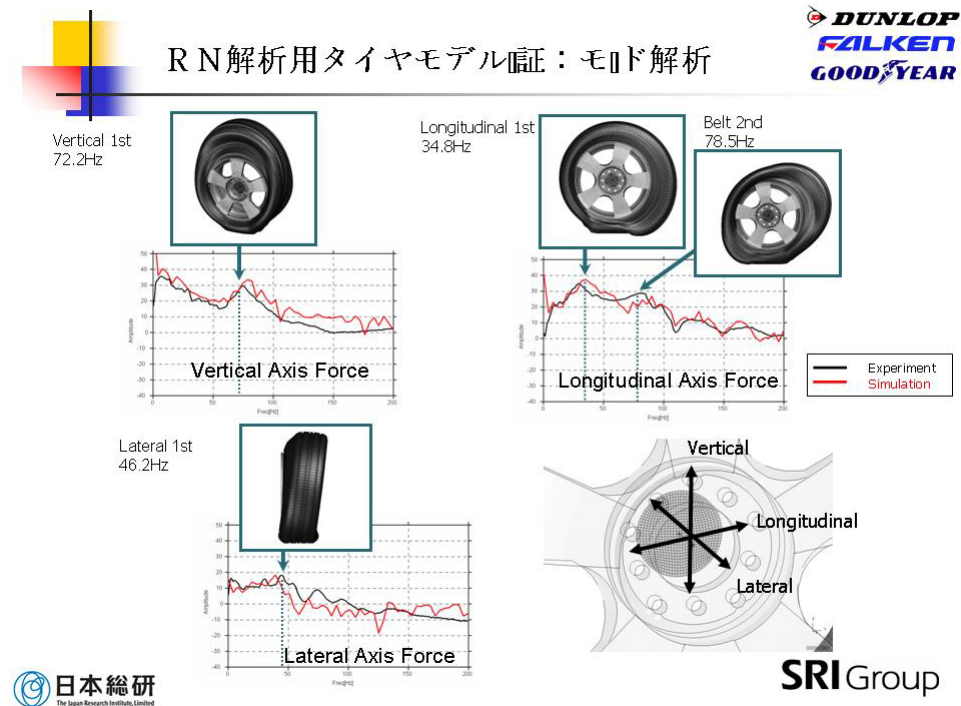


Verification of RN Tire Model : Tire Mode



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## Summary and Future

### (Summary)

- + The simplified tire model was developed. It is possible to simulate the vibration property up to 200HZ by this tire model.
- + It is possible to simulate the input force from the uneven road considering envelope effect by rolling on the road model of which the surface shape is modeled same as actual road.
- + It will be possible to simulate the road noise by running of the vehicle model with these tire models on the actual surface road model and considering the interactive effects between tire and vehicle.

### (Future)

- + Road noise verification by vehicle model with tire model
- + Modeling the cavity air (about 250HZ resonance) and simulate the vibration property up to 500HZ

