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# ***AIR SPRING***

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***Anti-vibration Suspension  
for Railcar Undercarriages***

# A WORLD LEADER IN THE RUBBER INDUSTRY

**Bridgestone was founded in 1931 and has grown to become the world's largest tire and rubber products company, with 179 production facilities in 25 countries and sales networks in over 150 countries.**

**The company is renowned for its R&D and design capability, exemplified by the success of Bridgestone's racing tires. This expertise extends to a wide range of products including automotive parts and industrial rubber products including Air Springs.**

***"Bridgestone... Serving Society with Superior Quality"***

**Bridgestone Air Springs:** High quality and safe anti-vibration suspension systems for a wide range of railcar vehicle undercarriages, including high-speed and intercity trains, metros and trams.

Part of the secondary suspension system, Air Springs play an important role in isolating the vibrations which naturally translate from the rail through the steel components of the undercarriage. High quality Air Springs provide damping by controlling both vertical and lateral movement. This brings comfort and stability to the passenger and also helps to reduce noise.

Bridgestone carefully selects the most suitable Air Spring for the needs of each application. Our Air Springs are manufactured in our own factories in Japan and are used worldwide, on high-speed trains such as the famous Shinkansen Bullet train in Japan as well as on urban railways and metros in Europe, India, China and the US.

The Bridgestone Group has many years of experience manufacturing and supplying Air Springs for trains, buses, trucks, cars and into a wide range of industrial applications.



# Technology

Bridgestone develops and makes raw materials such as natural rubber, synthetic rubber, carbon and other materials that are used in Air Springs. Bridgestone Air Springs possess the same unrivalled quality and reliability as other Bridgestone products.

A Bridgestone Air Spring is a carefully designed set of rubber/fabric bellows containing compressed air. The special design profile of the upper plate acts as a cradle for the bellows. When pressurised, the air within the bellows provides the necessary force and support load to isolate vibrations and accommodate large horizontal and vertical movements when travelling.

The combination of Bridgestone's high quality rubber and intelligent product design provides you with superior comfort and excellent reliability.

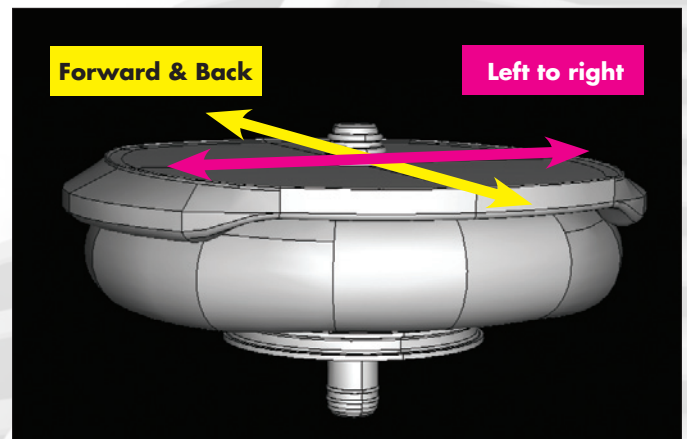
## Design Technology

### Bellows Shape Control

Bridgestone's Dual-Axis Air Spring provides unrivalled performance. The intelligent design profile of the upper plate controls the shape of the bellows. This improves spring ratio performance for forward & back, and left to right directions.

Our Dual-Axis technology therefore controls the movement and deformation of the Air Spring during travel, reducing vibration by more than 30% in the left to right axis compared to conventional omni-directional spring ratio Air Springs. This all adds up to much better ride comfort.

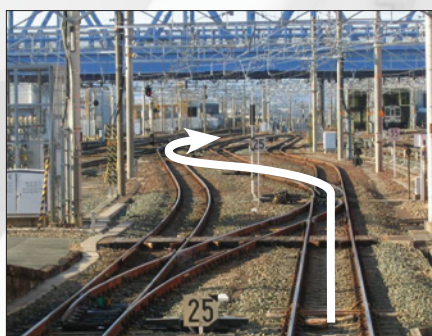
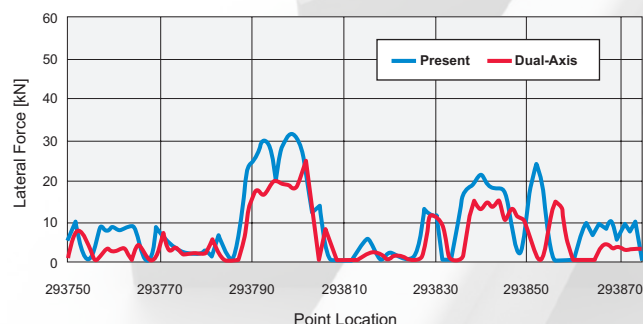
In the past, the lateral force between the wheel and rail increased when adjustments were made to improve ride comfort. But by correctly controlling the forward and back movement Bridgestone can now actually decrease those lateral forces.



## Field Testing

Field testing is an invaluable tool in identifying the types of movement and tendencies at speed.

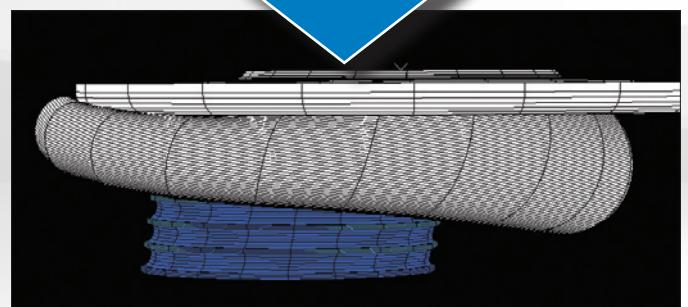
Using this method Bridgestone Engineers were able to prove they had a reduced lateral force by 10%.



## Simulation Technology

### FEA Characteristics Simulation

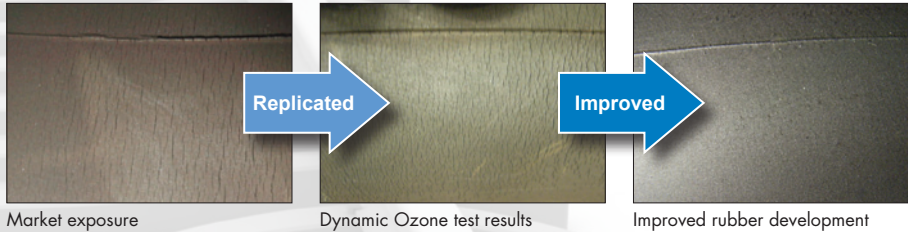
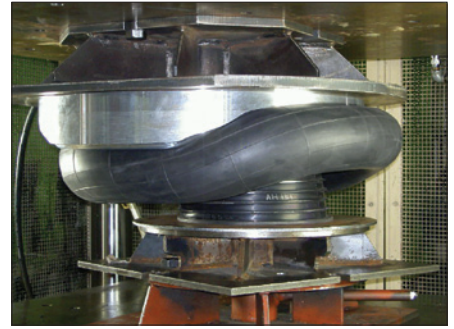
Bridgestone's scientifically proven Non-Linear Diaphragm Behaviour Analysis software helps our engineers to create new and innovative technologies.



## Rubber Compound Development and Evaluation Technology

Laboratory bench testing is very important to accelerate evaluation under controlled conditions. Bridgestone's dynamic acceleration test simulator replicates environmental conditions (Temp, Ozone etc) to get as close as possible to market conditions. Vital data provides feedback to our designers.

Below is an example of how Bridgestone engineers were able to produce an improved rubber compound as a result of replicating market conditions, accelerating tests and applying this to their knowledge of rubber.

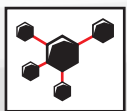


## Construction

### Compact Lightweight Design

By controlling the shape of the bellows we can achieve a reduced overall diameter and height. This allows for greater clearances with other components

**Self-Damping Orifice**  
No need for oil-damping



**Rubber Compound**  
The diaphragm is made using one of Bridgestone's advanced durable rubber compounds which is ozone and abrasion resistant

**Self-Sealing Upper and Lower Plate**  
No bolt fixing needed. Easy maintenance.

**Rubber-Coated Upper & Lower Plate**

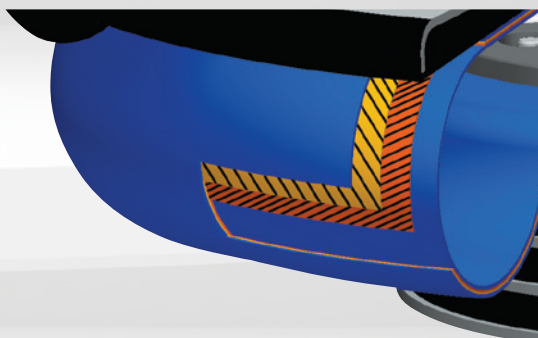
A rubber coated inner plate avoids metal to rubber contact with the bellows. This improves durability.

**Dual-Axis Upper Plate**  
Provides direction-controlled spring ratio.

**Flexible Bead Wire**  
High integrity sealing function developed from Bridgestone world leading tire technology.

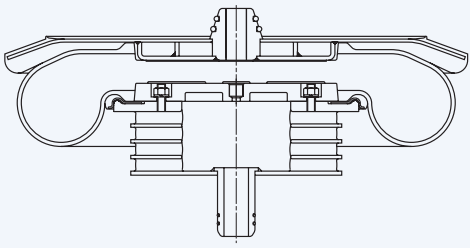
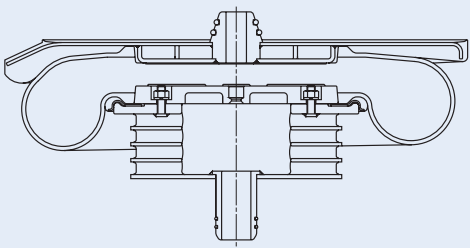
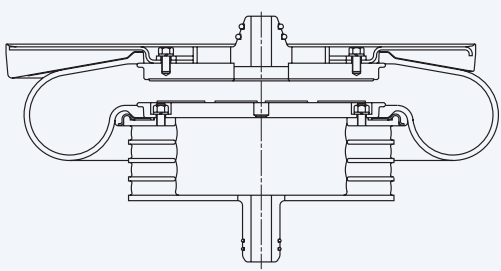
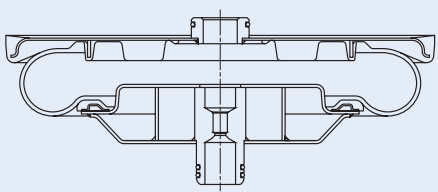
**Double-Function Vertical Stopper**  
Provides lateral movement and acts as an emergency stopper.

**Diaphragm Construction**  
The combination of high tensile strength internal nylon ply fabric and Bridgestone's high quality rubber produces a reinforced and durable rubber diaphragm



The Bridgestone range includes over 50 varieties of Air Springs with different diameters, membrane sizes and rubber compounds. By modifying the upper plate we can fine-tune the performance of our Air Springs to meet your requirements.

The 4 main categories of Bridgestone Air Springs are shown below.

Type	Effective diameter (mm)	Load at 0.5MPa kN	Lateral Deflection (mm)	Spring Rate (N/mm)	
				Vertical Static at 0.3MPa (Auxiliary Tank Lit)	Lateral Dynamic at 0.3MPa
<b>Omni Axis type with Self-seal for Bolsterless</b> 	Ø350 ~ Ø580	50 ~ 135	MAX ± 120	120 ~ 550 (30 ~ 70)	50 ~ 250
<b>Dual Axis type with Self-seal for Bolsterless</b> 	Ø450 ~ Ø560	80 ~ 135	~ ± 120	120 ~ 550 (30 ~ 70)	Right-Left
					Forward-Back
<b>Omni Axis type with Clamping for Bolsterless</b> 	Ø560	150 at 0.6MPa	± 110	350 ~ 400 (45)	160
<b>Omni Axis type with Self-seal for Bolster</b> 	Ø450 ~ Ø600	80 ~ 140	± 40	300 ~ 450 (45 ~ 60)	180 ~ 300



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Bridgestone Air Springs are manufactured at facilities that are recognized for their quality of management by the highest international certification standards:



**Quality Management Systems. ISO 9001/2000 Approved**



**Environmental Management Systems. ISO 14001**

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