
# Angst+Pfister Group

## How to improve comfort of Stage V tractors thanks to ‘ultra high-performance elastomeric materials’ with optimized mounts design?

Philippe Kirsch
International Business Development Director

Angst+Pfister

# Agenda

- Comfort increases productivity & protects user health
- Angst+Pfister in a nut shell
- Specific skills in Antivibration technology
- Customized engineering solutions
- Competences in development of ultra high-performance elastomeric materials
- Design optimization
- Rubber injection process
- Overall equipment effectiveness at Angst+Pfister Advanced Technical Solutions
- Challenges for Massey Ferguson tractors with stage V engines
- Influence of Stage V engines on cab mounts
- Key requirements for the development of such ultra high-performance elastomeric materials
- Overview cab mount solutions
- Best option with APSOvib® HD Conical bearings
- Specific cab mounts with bump stop feature for reduced cabin movement
- Comparison between cab mounts with bump stops vs. viscoelastic

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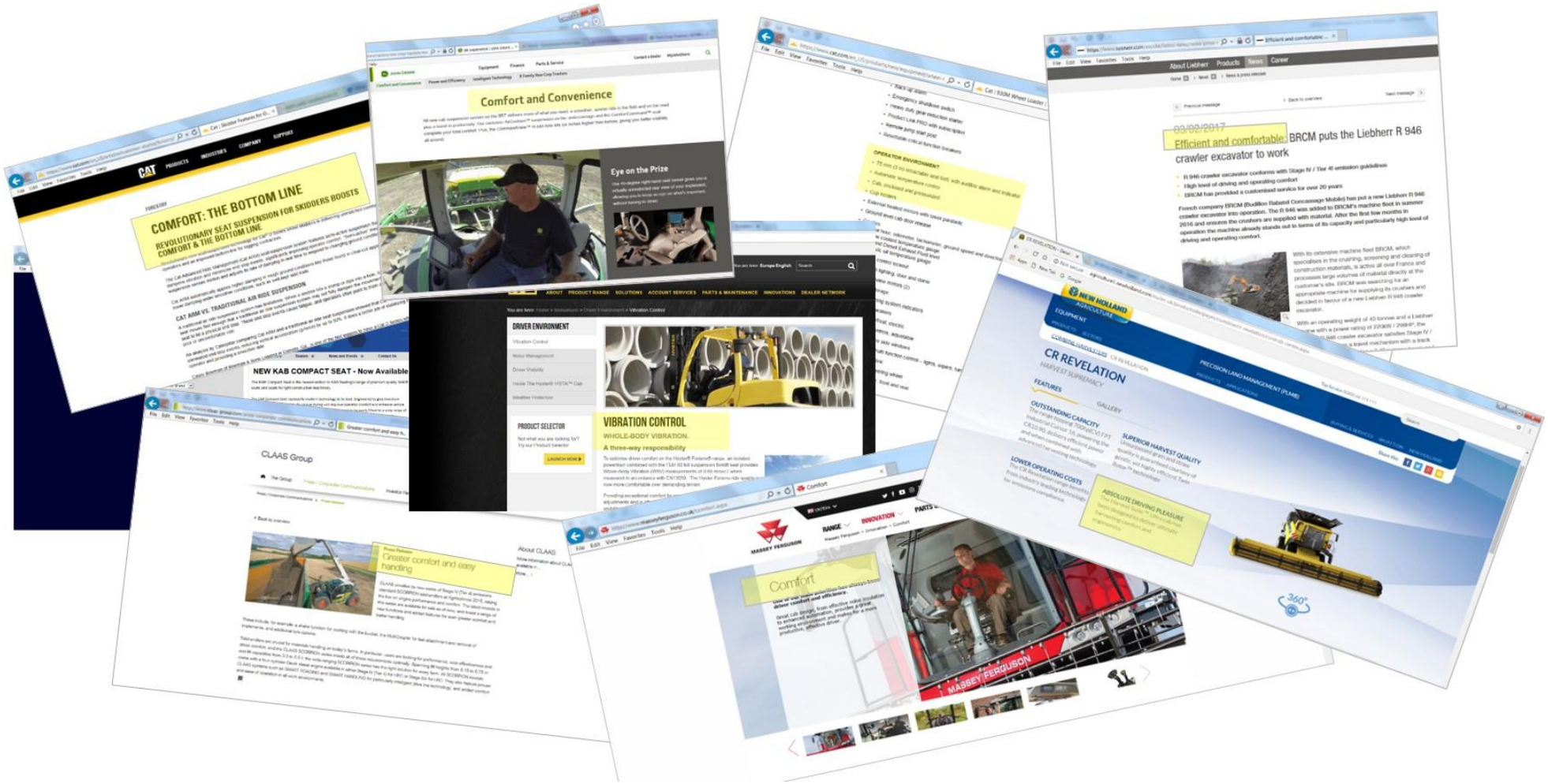
# Comfort increases productivity & protects user health

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# Comfort increases productivity & protects user health

| 1960's | | Comfort features | | Today |
|---|---|---|---|---|
|  | ✓ | Seat | ✓ |  |
| | | Seat suspension | ✓ | |
| | | Heating & Air conditioning | ✓ | |
| | | Ergonomic layout | ✓ | |
| | | Isolated powertrain | ✓ | |
| | | Noise insulation | ✓ | |
| | | Tilt & telescopic steering wheel | ✓ | |
| | | Cup holders, lunchbox storage, cab lightning, radio speakers, touchscreen controls, etc.… | ✓ | |



- In a purely utilitarian type of vehicle, not only technical aspects such as powertrain, transmissions, load & traction capabilities have evolved. Comfort has made a quantum leap

**Because comfort means:**

- **Productivity:** If the operator suffers from fatigue after the vehicle will stand idle
- **User Health:** Exposure to intensive and especially vertical vibrations can over the years lead to work-related illness

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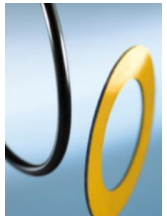
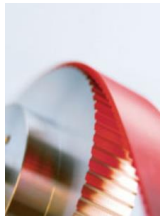
# Angst+Pfister in a Nut Shell

Angst+Pfister Group, a leading international technical manufacturer and service provider for high-end industrial components


APSOseals®



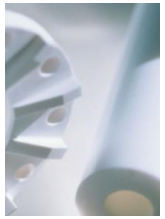
APSOdrive®



APSOvib®

APSOfluid®

APSOplast®



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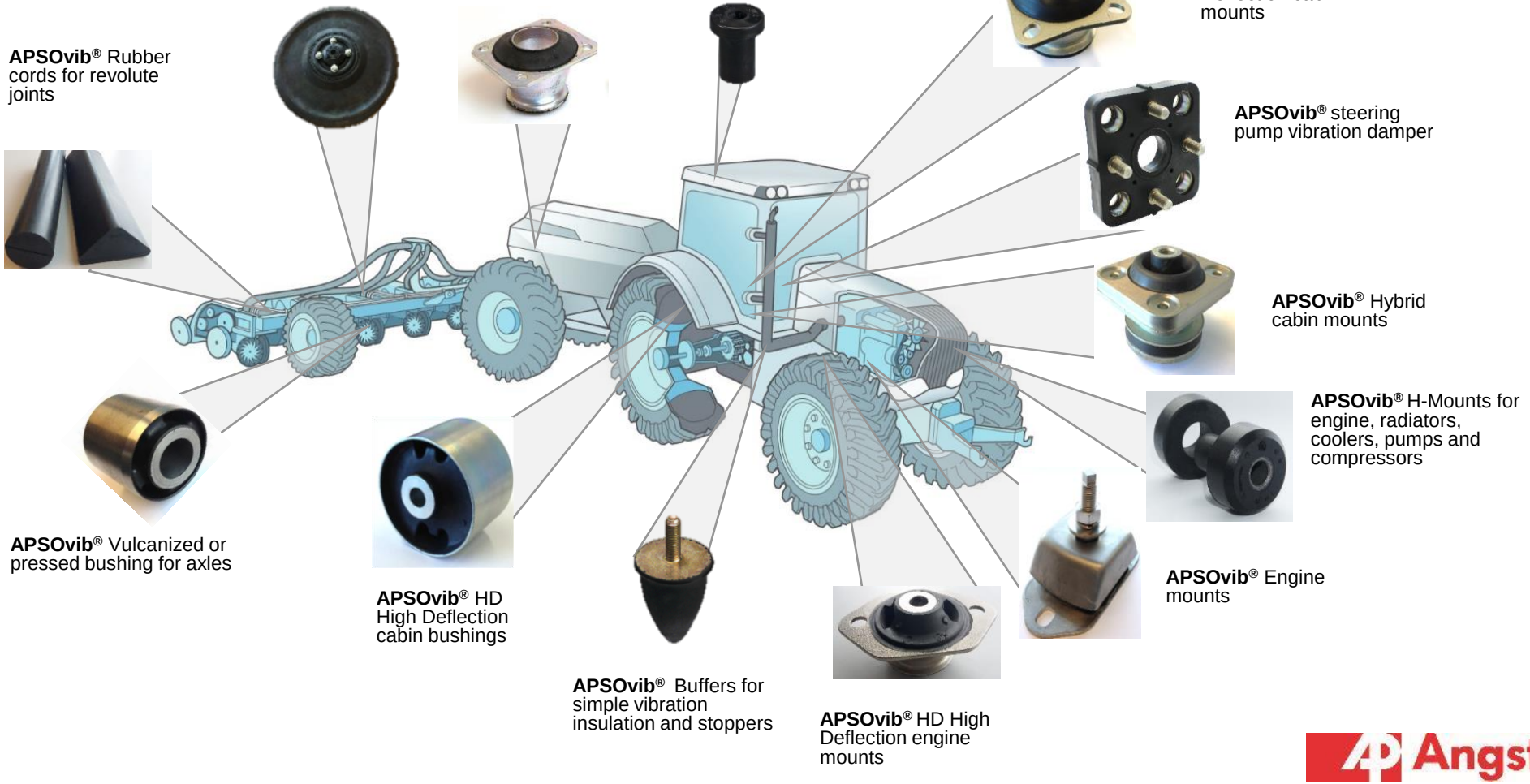
# Specific Skills in Antivibration Technology

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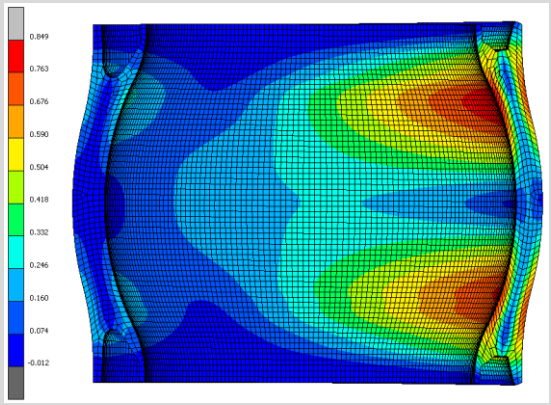
# Customized Engineering Solutions




## Customized Engineering Solutions

- Our engineers include specialized product application experts
- Our depth of knowledge in both materials and production processes
- Our virtual design, finite element analysis and endurance testing
- Our ability to provide innovative solutions produced internationally

**= Accelerating the time-to-money and reducing total cost of ownership**

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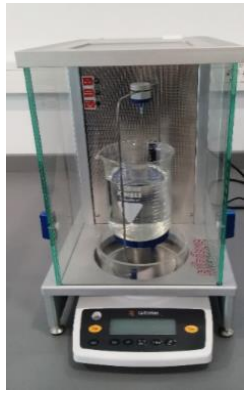
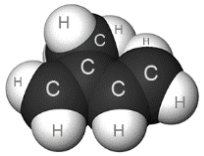
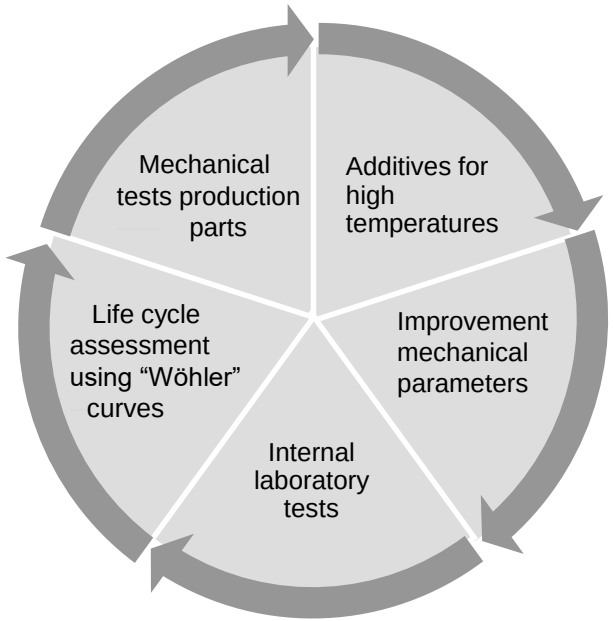
# Competences in Development of Ultra High-Performance Elastomeric Materials








- Halogen-based substances
- Phosphorus-based substances
- Minerals
- Blended polymers
- Special synergistic additives

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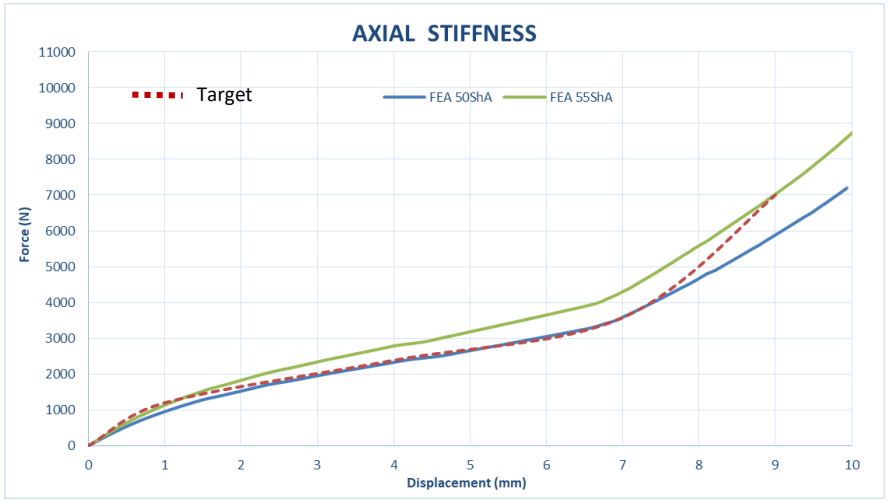
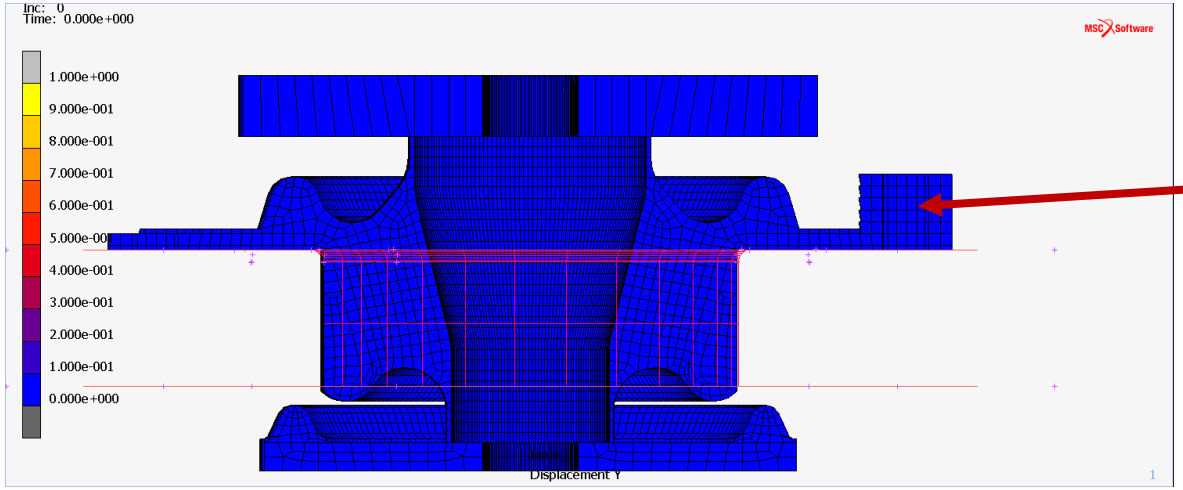
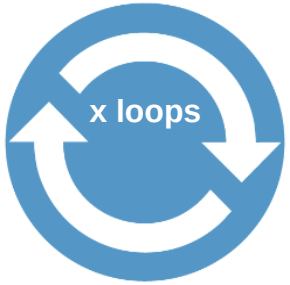
# Design Optimization




**FEM Finite Element Method**

- Static stiffness calculation
- Dynamic stiffness calculation: stiffness in the required frequency range
- Stress / Strain distribution
- Time dependent analysis: creep & stress relaxation

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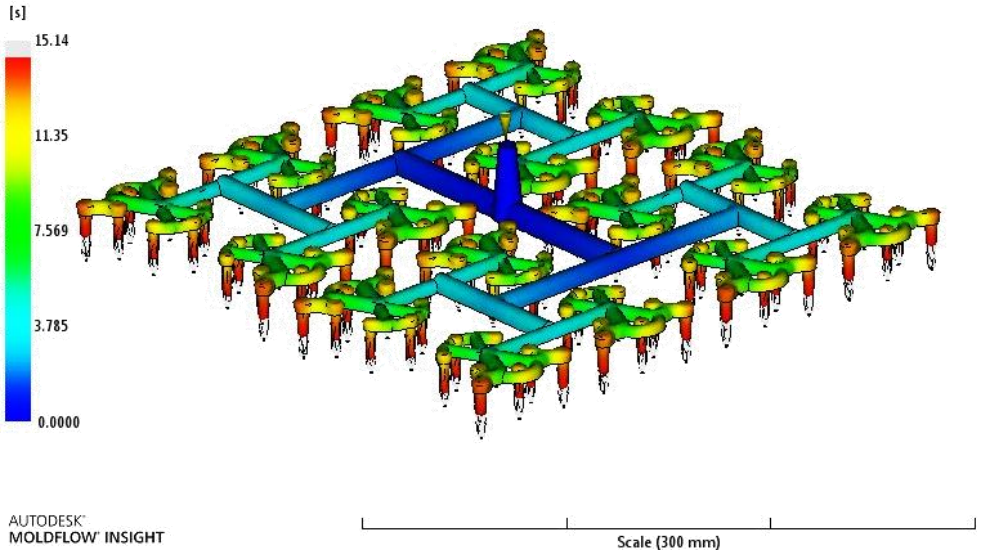
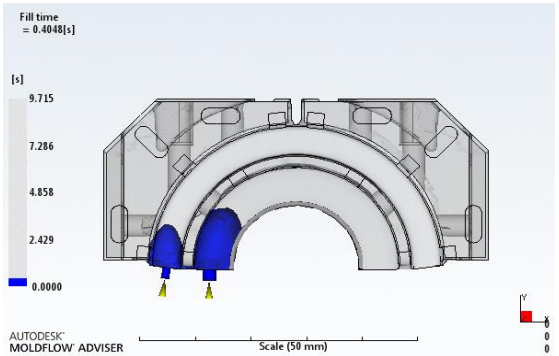
# Rubber Injection Process

## Mold flow

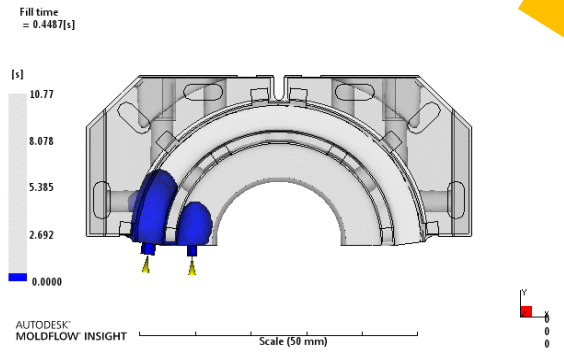



After the development of the rubber compounds, the vulcanization process is essential to ensure the consistent quality of the finished product!

## Current Design




## Improved Design




Optimized injection size for uniform fill in outer and inner rubber layers

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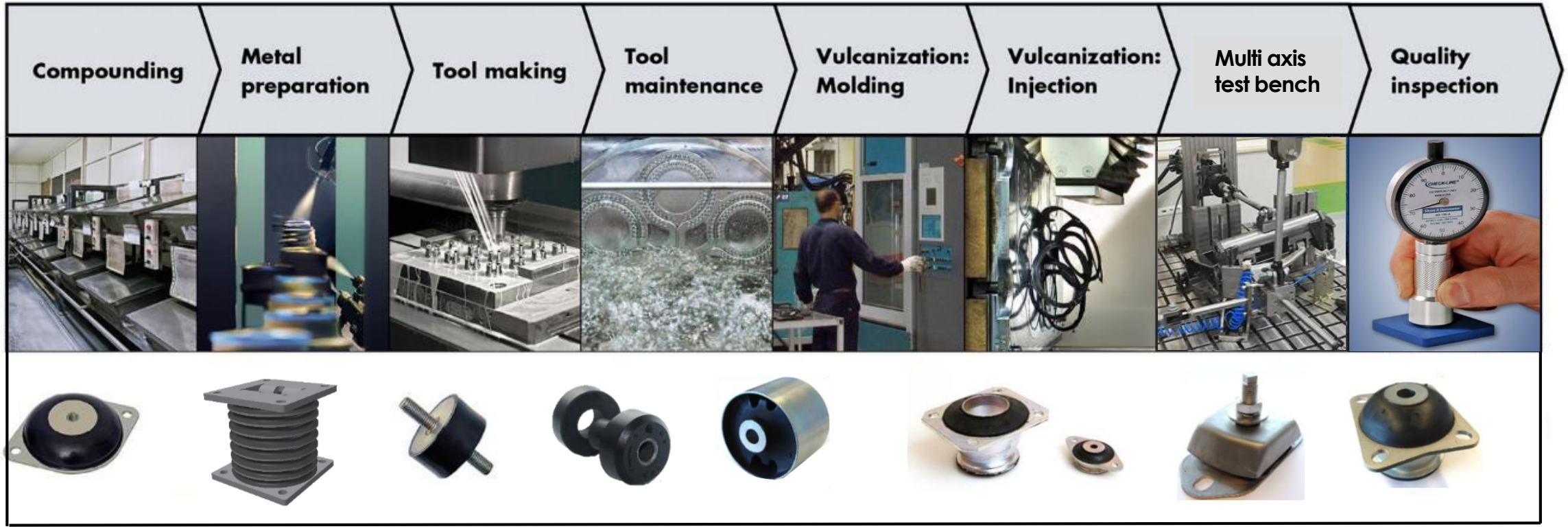
# Overall equipment effectiveness at Angst+Pfister Advanced Technical Solutions

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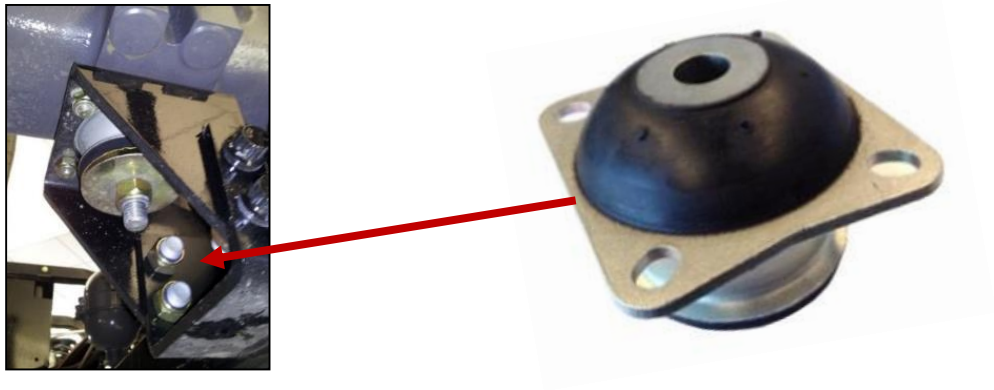
# Challenges for Massey Ferguson tractors with stage V engines

## Cab mounts for Massey Ferguson tractors 7719 S



## Challenges

- Insulation of the cab from engine vibrations and shocks due to off-road driving, improvement of interior comfort to reach a noise level < 68 dB
- Operating temperatures up to 110°C, front supports are close to exhaust gas treatment
- No compromise on lifetime, must meet AGCO's requirements
- Solution must remain at an acceptable price
- Fully interchangeable with the previous version but with different color marking

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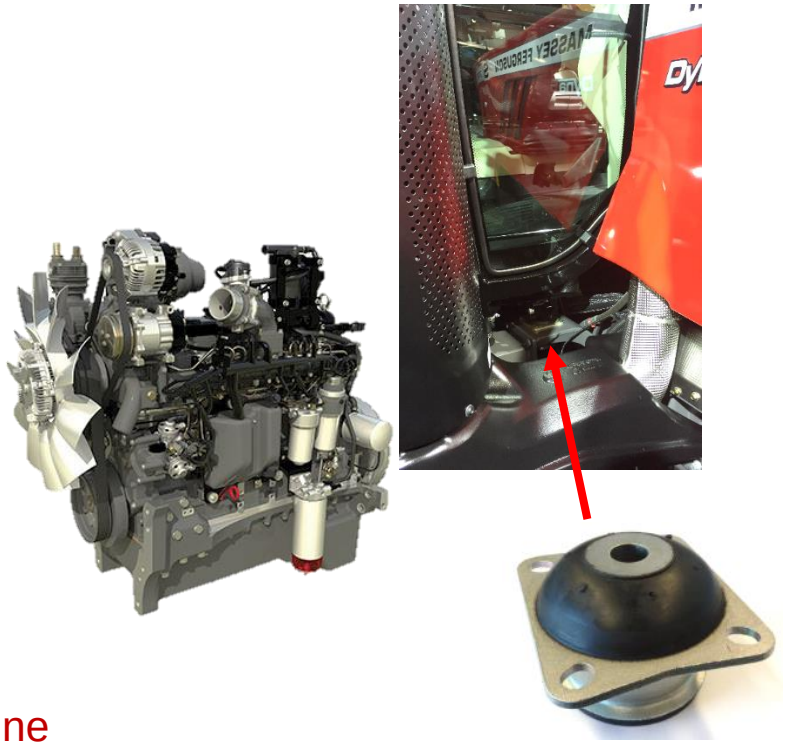
# Influence of Stage V Engines on Cab Mounts

**What is “Stage V”?**

- Emission standard for non-road mobile machinery

**What does that mean?**

- To comply with the emission regulation Stage V, all engines are equipped with exhaust gas after treatment systems which generates a significant increase in temperature
- This is particularly critical with tractors because this system is located between the engines and the cabs
- Standard cab supports can no longer meet these thermal requirements with such high mechanical loads, which is why we have developed a new **ultra high-performance elastomeric material**



Massey Ferguson developed a maintenance free All-In-One system that is in line with the latest engine regulation Stage V. It uses a combination of an SCR (Selective Catalytic Reduction) and SC (Soot Catalyst) and both are operating without any need of DPF (Diesel Particulate Filter) or active regeneration.

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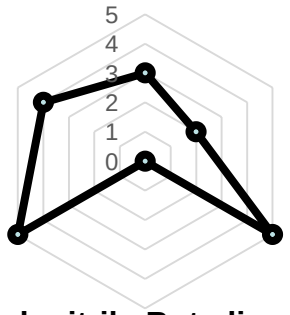
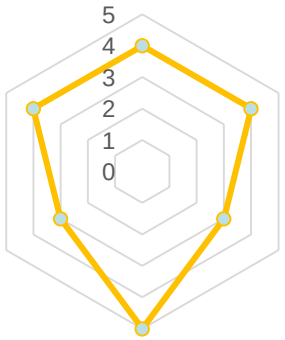
# Key Requirements for the Development of such Ultra High-Performance Elastomeric Materials

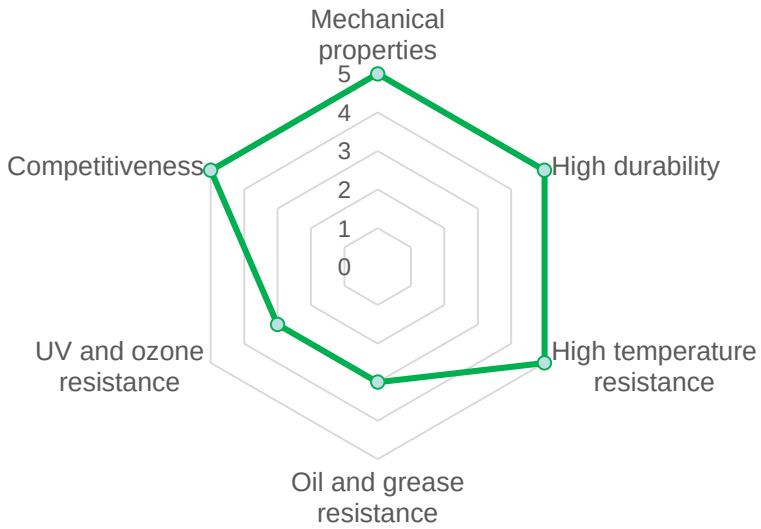
**EPDM Ethylene Propylene Diene rubber**




**NBR Acrylonitrile Butadiene rubber**



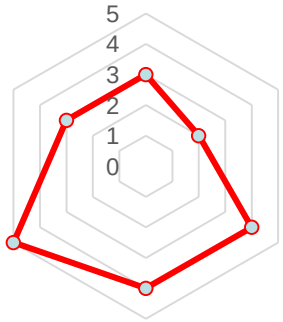

**Ultra high-performance elastomeric materials**



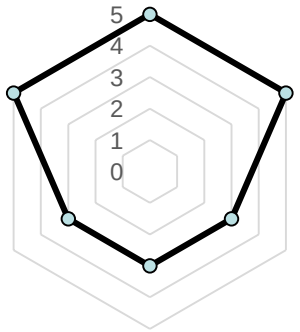

**Key requirements to meet AGCO expectations:**

- Excellent mechanical properties
- High durability
- High temperature resistance

**CR Chloroprene rubber**




**NR Natural rubber**

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# Typical Cab Mount Solutions

| Type | APSOvib® HD Conical bearings | APSOvib® 2- Stage cab mounts | APSOvib® Hybrid mount |
|---|---|---|---|
| |  |  |  |
| **Advantages** | • Different X, Y & Z stiffness<br>• Continuous stiffness progression<br>• Long lifetime due to conic shape<br>• Standard article<br>• Easy to assemble<br>• Simple part identification with markings | • Specific bump stop feature for reduced cabin movement<br>• Simple design<br>• Easy to assemble<br>• Partially standard article*<br>• Low & linear vertical stiffness in the static range<br>• Steel is mostly covered in rubber and protected from corrosion<br>*Adjustments according the final cabin weight might be needed | • High damping end stops<br>• High impact energy absorption<br>• Low damping in static range to improve vibration isolation<br>• Design according customer requirements |
| **Disadvantages** | • No individually defined bump- stop<br>• High cabin amplitudes can occur | • Bump-stop is limited to the same compound as the whole part | • Different types of rubber require additional vulcanization steps |
| **Unit Price** | *** | ** | **** |

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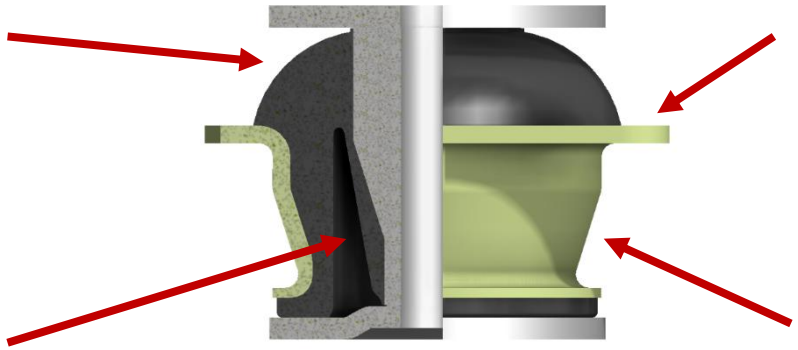
# Best Option with APSOvib® HD Conical Bearings

**Progressive Behavior**

- Continuous increase in stiffness to protect from excessive deflections



**Marking**

- ‘Easy to read’ marking for identification
- Marking can be customized

**Axial and Radial Stiffness**

- Different X, Y and Z stiffness for ‘Type 1’, asymmetric
- Low vertical stiffness to reduce engine vibrations
- Low lateral stiffness to increase overall isolation efficiency
- High longitudinal stiffness to avoid high amplitudes under braking or accelerating
- Similar X and Y stiffness for ‘Type 2’, symmetric

**Coating**

- Zinc coating to protect from corrosion
- Optional Zinc-Nickel-coating for increased durability

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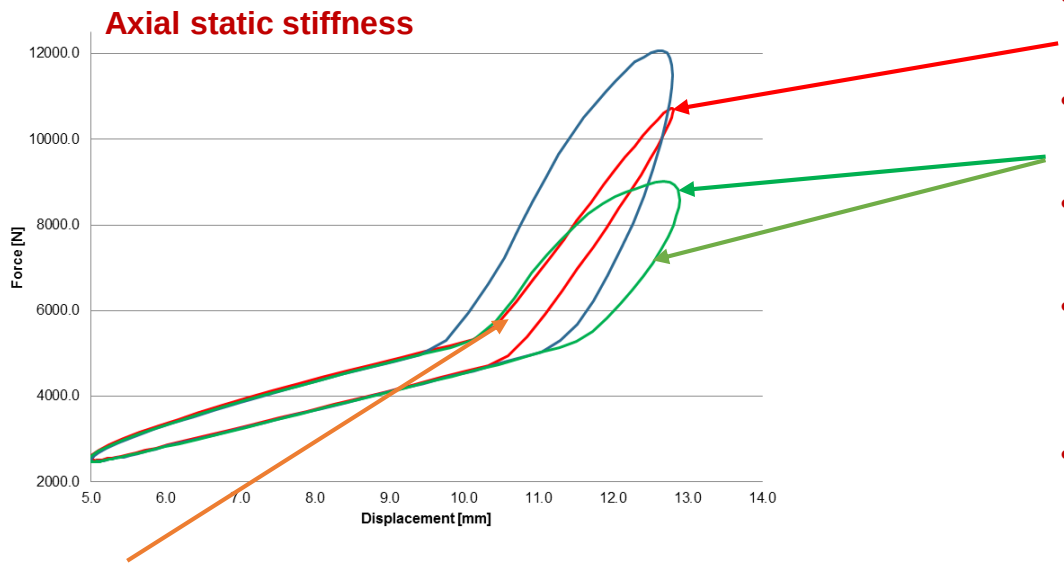
# Specific Cab Mounts with Bump Stop feature for reduced Cabin Movement

## Mechanical characteristics - Static




## Working Range

- Typical static deflection at 5 mm
- The deflection at which the bump stop is in contact is defined by the position of the washer and the dimensions of the bump stop

## Behavior of the Bump Stop

- Based on the selected rubber compounds, damping effect can be changed
- For the red curve, the same compound was used for the washer and for the main part
- The blue & green curve show a high damping rubber for ideal energy absorption
- **For ideal vibration isolation, the hysteresis should be low**
  **'Main part rubber compound'**
- **For ideal shock absorption, the damping should be high**
  **'Bump stop rubber compound'**

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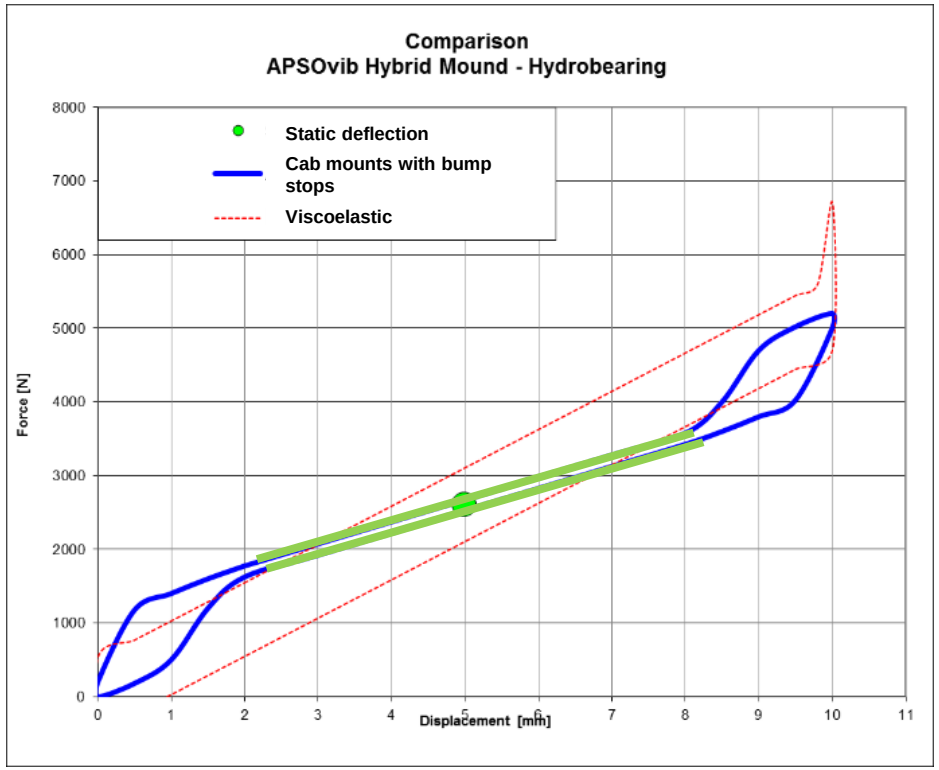
# Comparison between cab mounts with bump stops vs. viscoelastic

## Mechanical characteristics - Static

**Axial static stiffness**




## Cab mounts with bump stop vs. viscoelastic

- The curves show the difference in static behavior of the cab mounts with bump stops vs. viscoelastic
- In the **static vibration range** (2600 N ± 0.5g) the hysteresis is much lower for the **cab mounts with bump stop**
- The isolation efficiency above the resonance frequency is improved without viscoelastic damping
- After 8 mm of deflection, the hysteresis is greatly increased to absorb more energy

**The cab mounts with bump stops are designed with a low hysteresis in the working range for ideal vibration isolation.**

**The bump stops with their high damping characteristics help to absorb the energy of shock impacts without influencing the static working range!**

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# Questions?


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