Glass Performance Days 2025

10 – 12 JUNE 2025 | NOKIA ARENA - TAMPERE, FINLAND

GLASS PERFORMANCE DAYS 2025

# SIMULATION OF WINDSHIELD PERFOMANCE ACROSS DIVERSE LAMINATE THICKNESSES, GLASS CONPOSITIONS, AND DESIGNS

OLGA PANINA, NIKOLAI ANTIPIN, SERGEY SHUBIN (CORNING)

# Outline

- Background
- Modeling Approach
- Validation
- Evaluation of Asymmetric Windshield Constructions
- Summary

# Background

- Industry Standard - Pedestrian Protection Test


https://www.euroncap.com/en/car-safety/the-ratings-explained/vulnerable-road-user-vru-protection/head-impact/

- Conventional Windshield: 2.1/1.6mm SLG
  - Well studied performance
  - Established simulation approaches
  - Not changed since 1960s


**Does it address needs of modern vehicles?**

# Background

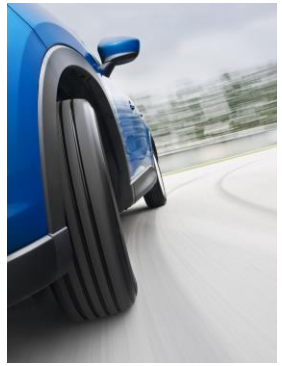
**Pressing need in innovative windshields solutions**

- Replacement cost rise → **Enhanced Durability**

- Optical Performance → **Thin, Excellent optics**


Leonhard, T., Cleary, T., Moore, M., Seyler, S. et al., "Novel Lightweight Laminate Concept with Ultrathin Chemically Strengthened Glass for Automotive Windshields," *SAE Int. J. Passeng. Cars - Mech. Syst.* 8(1):2015, doi:10.4271/2015-01-1376.

- $CO_2$ reduction and fuel economy → **Lightweight**



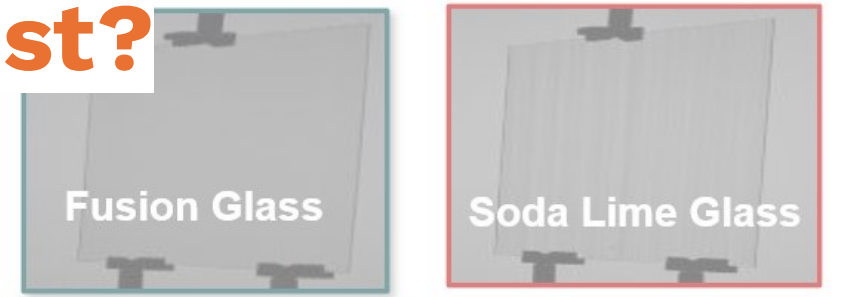
# Background

**Corning® Fusion5® and Corning® Gorilla® compositions in asymmetric windshields address industry needs**

- **Enhanced Durability**
  - 2-6 times better sharp impact resistance
  - 5x better scratch performance
  - >2x better thermal shock resistance


**What about the performance in the Pedestrian Protection test?**

- **Thin and Excellent Opti**
  - Less thickness (0.7 mm v
  - 2x lower optical distortion over SLG
  - > 2x lower optics decay



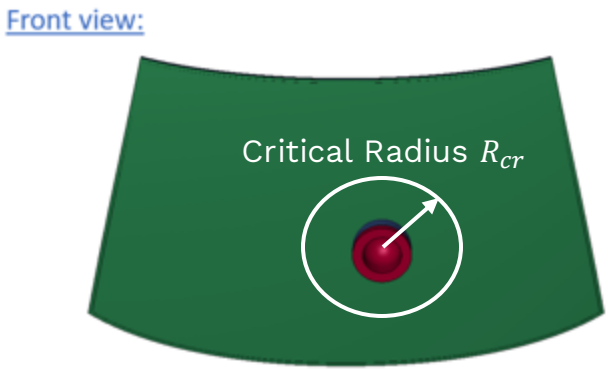

*Photos with shadowgraph at 60 degrees tilt*

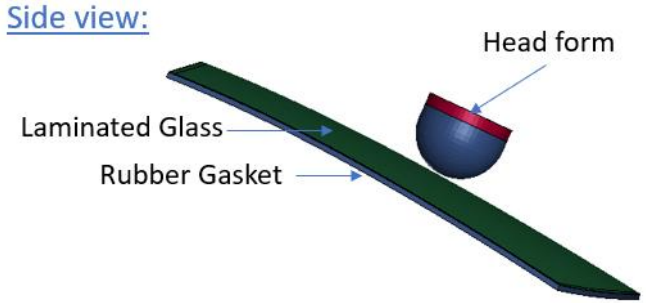
- **Lightweight**
  - 12% lower density (Fusion5® vs. SLG) + weight savings due to thinner glass

# Modeling Approach

**Laminated Glass:**
- Glass: shell elements
- PVB: solid elements

**Head-form:**
- Brainpan
- Skin





**Glass Failure Criterion:**
- Proposed by Pyttel* et al. non-local failure criterion with parameters:
  - Critical Tensile and Compressive Stress $f_c, f_t$
  - Critical Radius $R_{cr}$
  - Critical Energy $E_{cr}$

Implemented in MAT_280 LS-DYNA Software

Rankine failure criterion is violated : $-f_c < \{\sigma_1, \sigma_2\} < f_t$

**and**

Internal energy $E$ inside a circle $R_{cr}$ exceeds $E_{cr}$

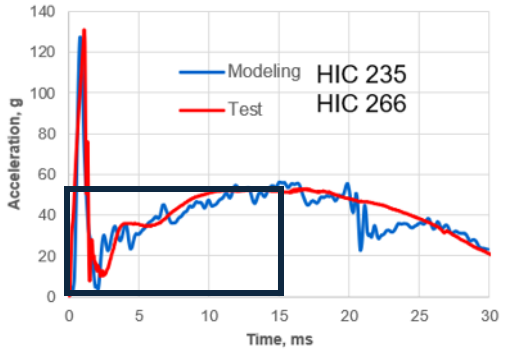
(*)Failure criterion for laminated glass under impact loading and its application in finite element simulation; T. Pyttel, H. Lieberz, J. Cai

# Validation

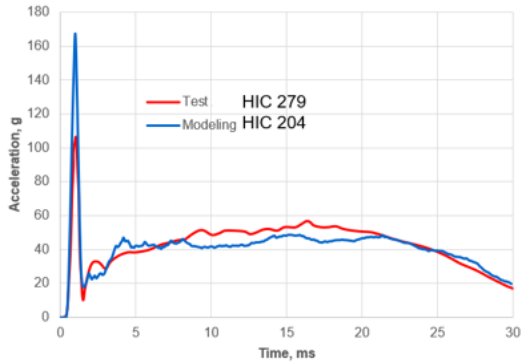
$$HIC = \max_{t_1,t_2} \left\{ (t_2 - t_1) \cdot \left[ \frac{1}{t_2 - t_1} \int_{t_1}^{t_2} a(t)dt \right]^{2.5} \right\}$$

## Shape

Shape 1



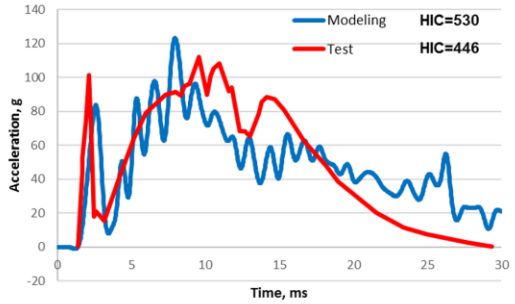

Shape 2



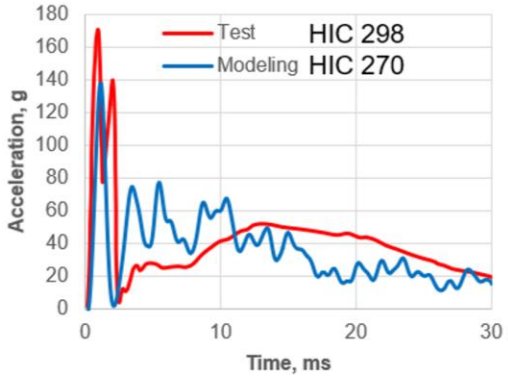

**Accuracy is independent on windshield shape**

## Glass Composition

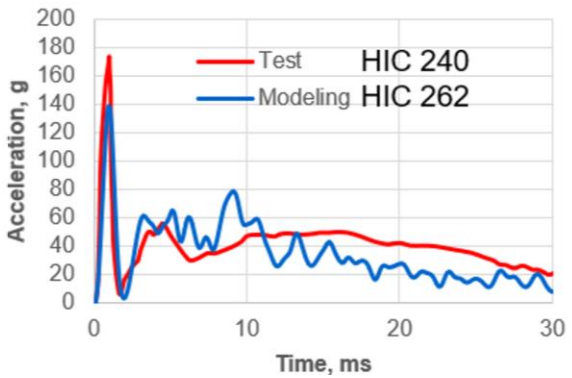
2.1 mm SLG/ 0.76 mm PVB/ 0.7 mm Gorilla® Glass




3.0 mm Fusion5®/0.76 mm PVB/1.6 mm SLG



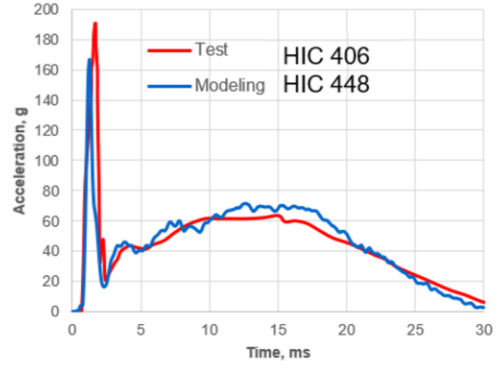

3.0 mm SLG/0.76 mm PVB/1.6 mm SLG



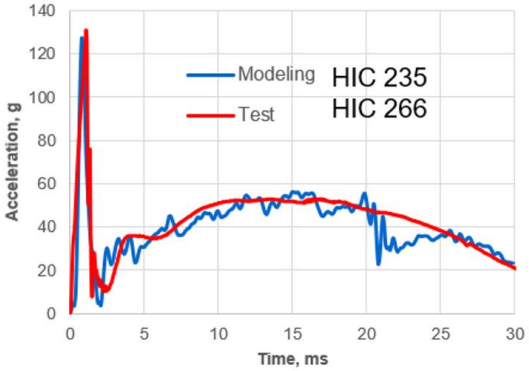

**Well predicted performance for various compositions and thicknesses**

## Head-Form Type

Child Head




Adult Head



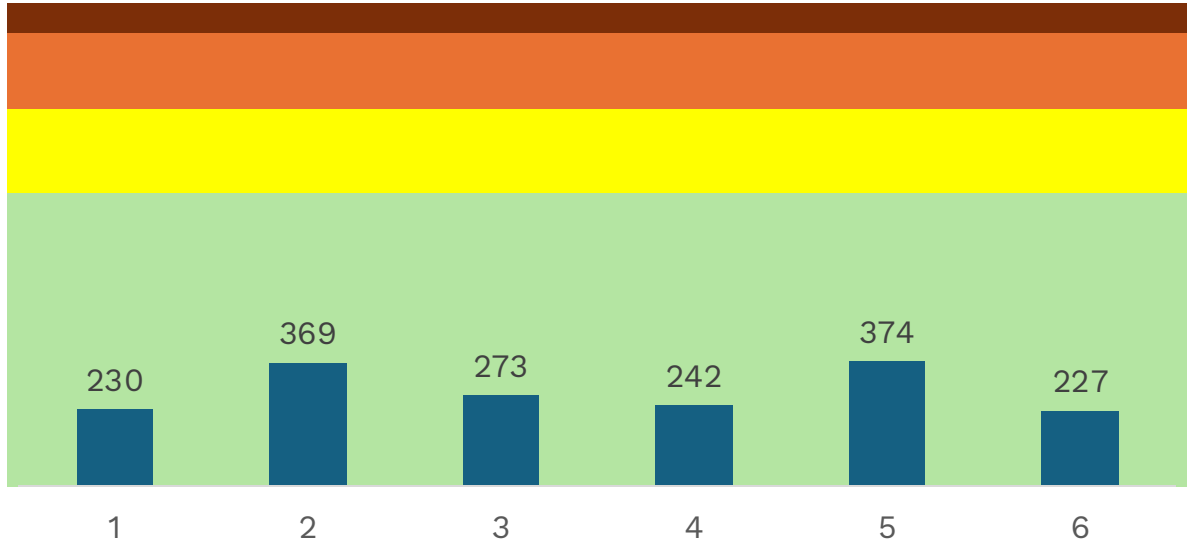

**Accurate for all head-form types**

# Evaluation of Asymmetric Windshield Constructions

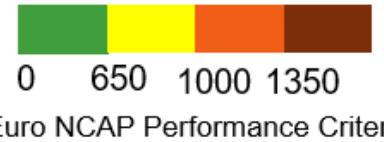
**Explore performance in the pedestrian protection test:**

1. 2.1 mm SLG/ 0.76 mm PVB / 1.6 mm SLG ← Conventional windshield
2. 3.3 mm Fusion5® / 0.76 mm PVB / 0.7 mm Gorilla® Glass
3. 3.3 mm Fusion5® / 0.76 mm PVB / 1.2 mm Fusion5®
4. 2.7 mm Fusion5® / 0.76 mm PVB / 1.6 mm SLG
5. 1.8 mm Fusion5® / 0.76 mm PVB / 0.7 mm Gorilla® Glass
6. 2.1 mm Fusion5® / 0.76 mm PVB / 1.6 mm SLG

} Asymmetric laminates with novel glass compositions for windshields



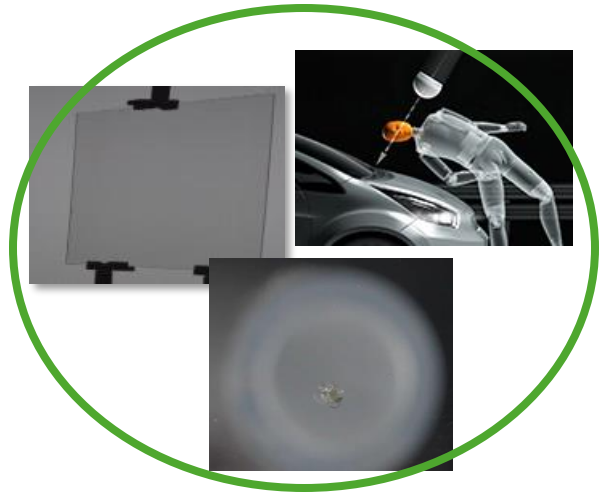

- All HIC values <650 – highest test score
- Almost the same results as conventional WS
- Little effect on the performance in pedestrian protection test



# Summary

- Corning® Fusion5® and Corning® Gorilla® glass address industry needs

- Novel constructions benefits:
  - Superior sharp impact, scratch and thermal shock resistance
  - Thin and excellent optics
  - Lightweight



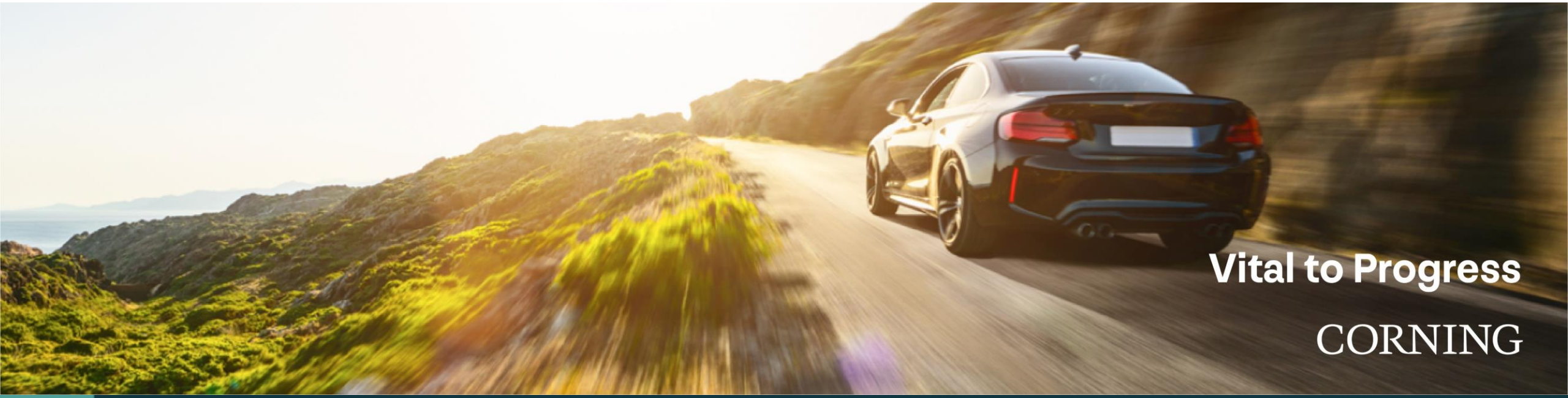
- Robust Pedestrian Protection Test modeling approach demonstrates the little effect of novel constructions on the test result

# Conclusion

Interested in Corning Auto-Exterior glass for your product or collaboration?

Let’s get in touch!

Olga Panina, Staff Scientist (Corning Scientific Center, Helsinki)
paninao@corning.com




Glass
Performance
Days 2025
10 – 12 JUNE 2025 | NOKIA ARENA - TAMPERE, FINLAND