The simulation of fracture prediction by the damage model GISSMO in various materials of sheet metal

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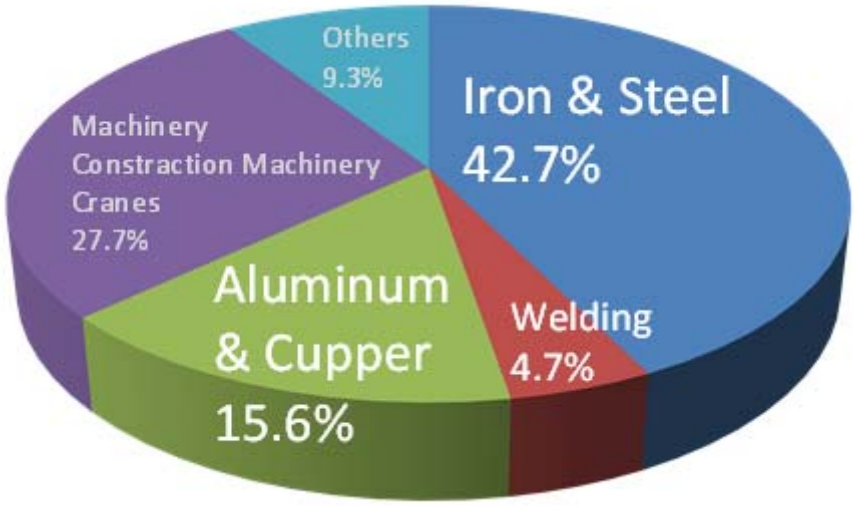
Introduction of KOBE STEEL

➢ Composition of Net Sales by Business Segments



✓ Consolidated Sales (2013)
1,824.7 Billions of Yen
1,3000 Millions of Euro

✓ Iron & Steel
sheet, plate, wire/bar …
✓ Aluminum
sheet, extrusions, forgings …

KOBE STEEL has both **Iron & Steel and Aluminum** business segments, which is **unique and rare** company in the world.

Steel products

Aluminum products

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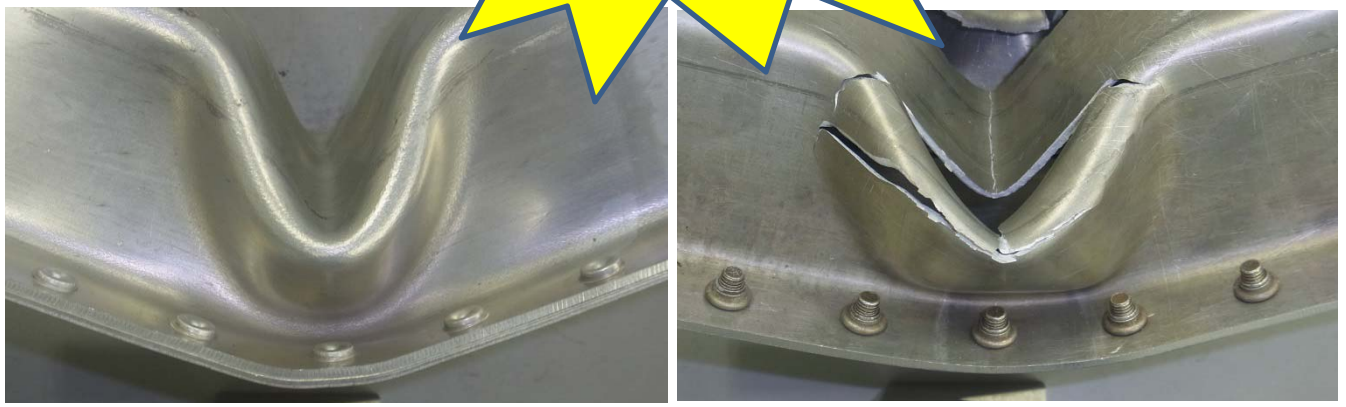
1. Motivation

- Demands of car body
  - Weight saving
  - Collision safety
- Application to car body
  - Higher strength
  - Thinner thickness
  - Aluminum alloy

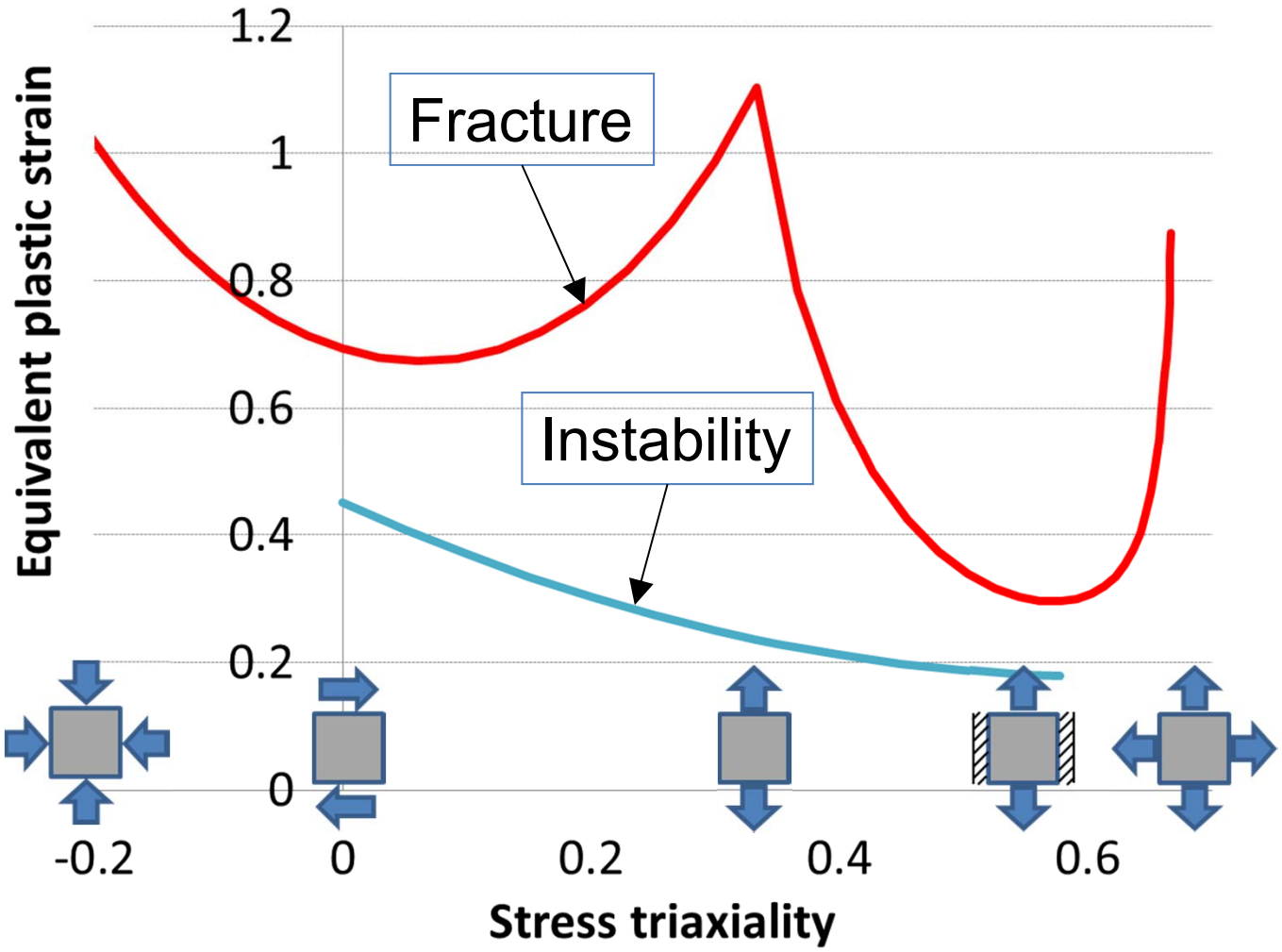
Reduction of ductility



- Numerical fracture prediction is a strong requirement

1. Motivation - GISSMO (short description)

GISSMO : *MAT_ADD_EROSION (IDAM=1)

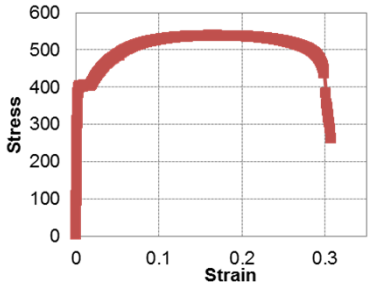


Material samples

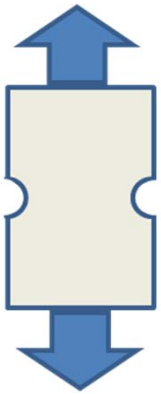
- PHS (TS 1500MPa grade)
- UHSS (TS 980MPa grade)
- HSS (TS 590MPa grade)
- Al6022-T6 (TS 220MPa grade)
- Al7075-T6 (TS 570MPa grade)

For Stress-Strain curve

Tensile test

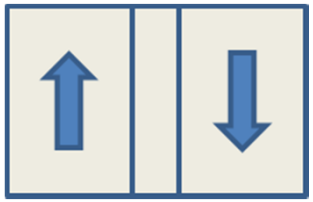


For fracture strain



Uniaxial

Plane strain



Shear

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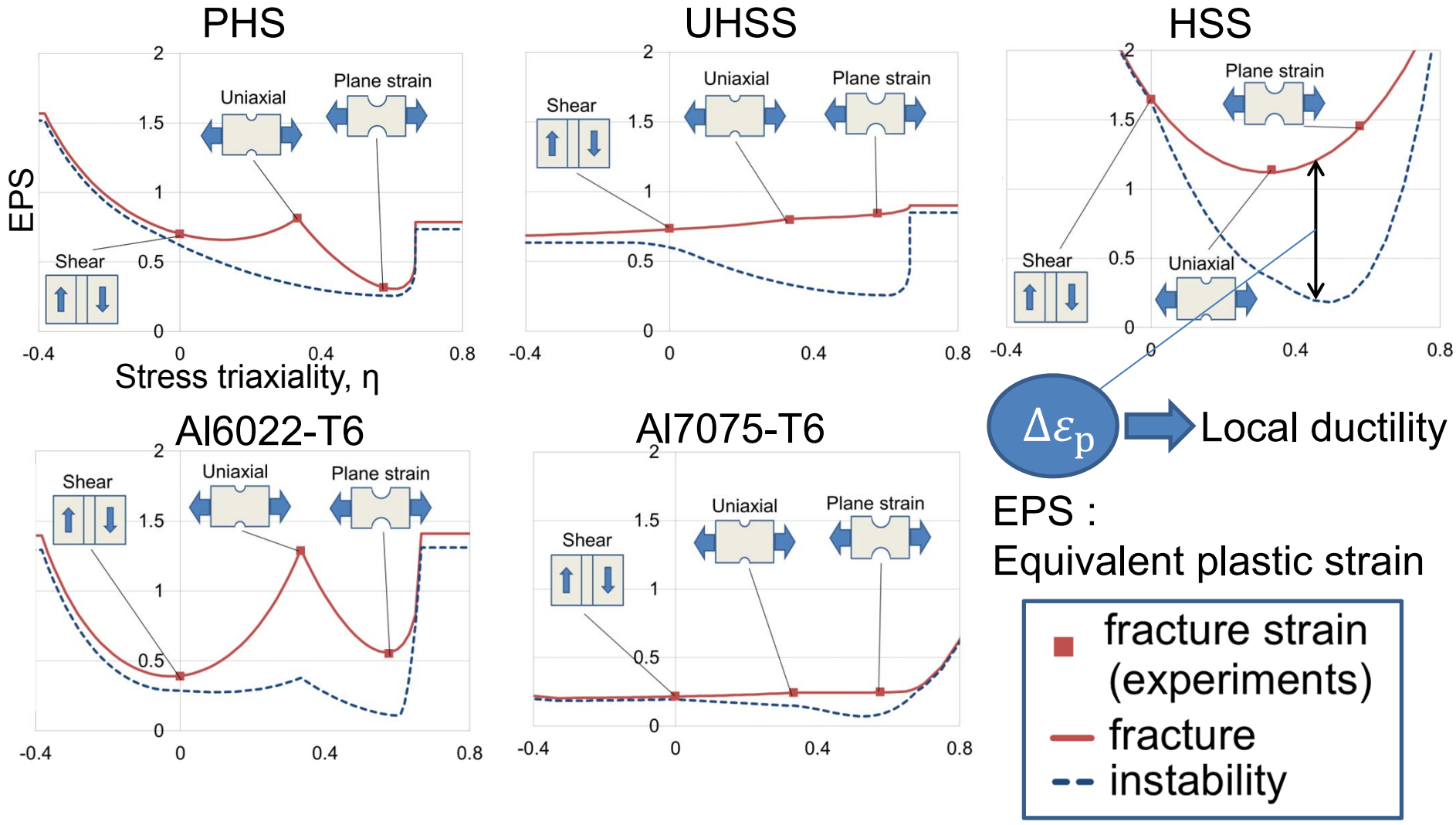
3. Failure criteria for GISSMO



- ✓ Magnitude relationships of the fracture strains are different depending on materials.
- ✓ The correlation between $\Delta\varepsilon_p$ and the local ductility is confirmed.

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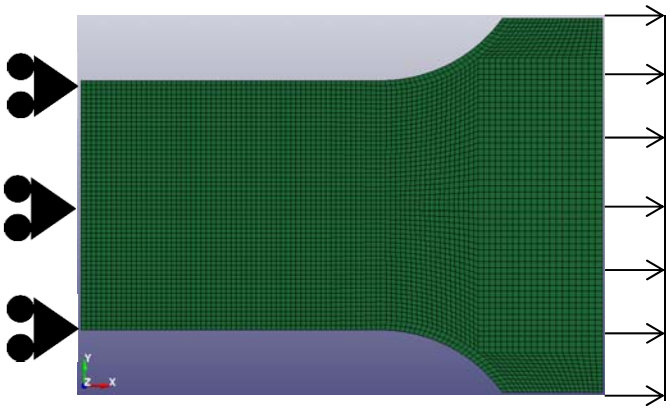
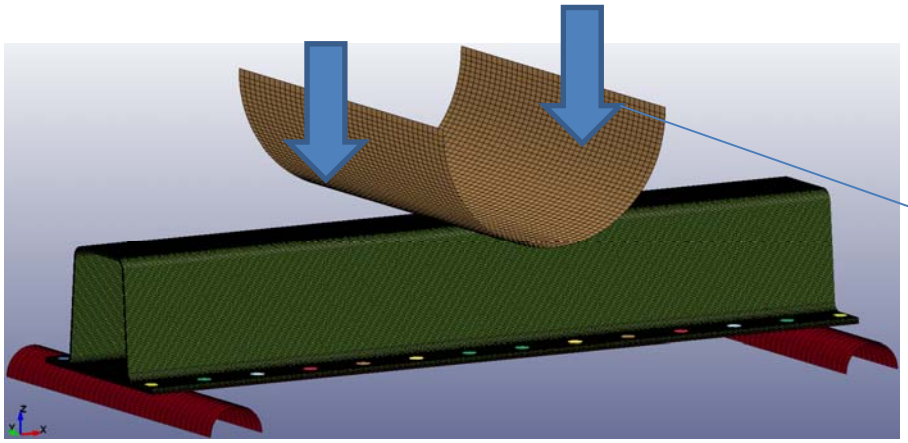
Numerical models

■Tensile test (1/2 model)



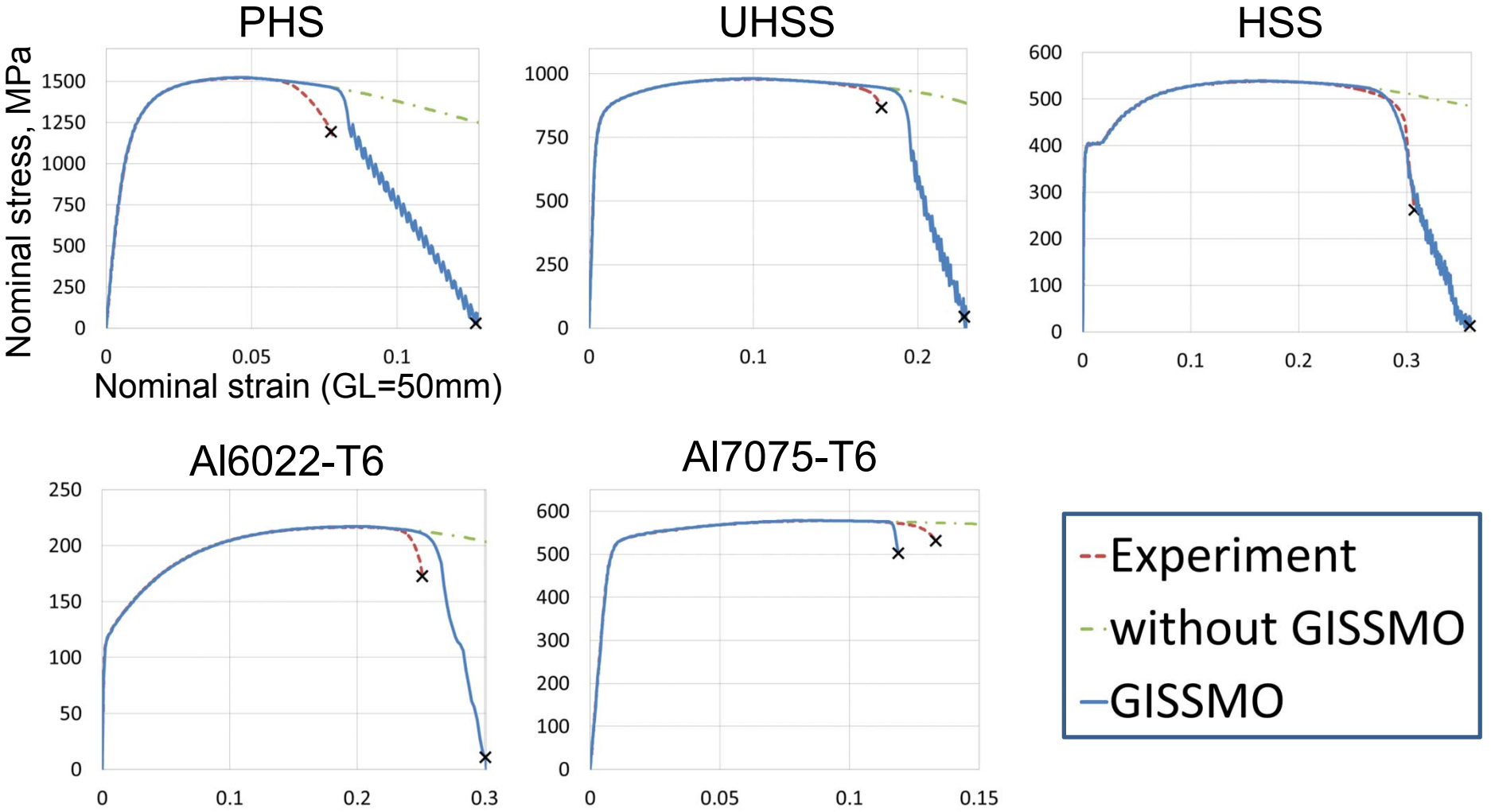
- Solid element size (flat area)
  $0.5 \times 0.46 \times 0.4$ [mm^3]
- Tensile speed
  1000mm/sec
- Material card : *MAT_024
  (& *MAT_ADD_EROSION)
  (*MAT_PIESEWISE_LINEAR_PLASTICITY)

■ Quasi-static HAT 3-point bending test



- Solid element size (flat area of HAT)
  $0.62 \times 0.57 \times 0.35$ [mm^3]
- Loading speed
  500mm/sec
- Material card : *MAT_024
  (& *MAT_ADD_EROSION)
  (*MAT_PIESEWISE_LINEAR_PLASTICITY)

4-a. Tensile test

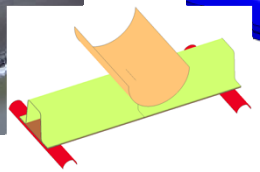


✓ It is confirmed that the fracture prediction can be performed accurately using GISSMO.

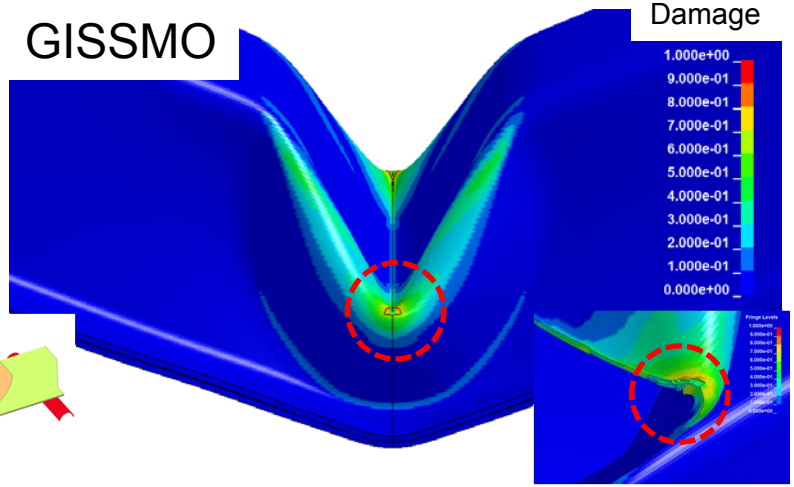
4-b. Quasi-static HAT 3-point bending test

PHS

Experiment

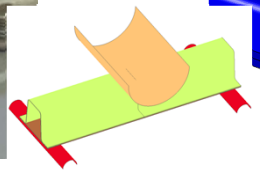


GISSMO

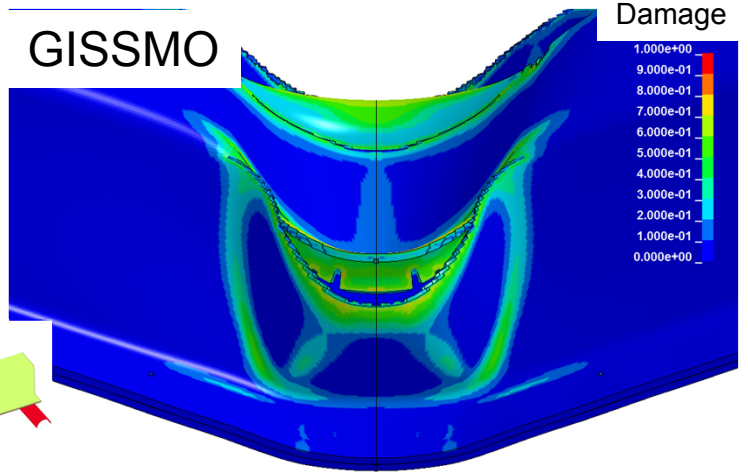


Al7075-T6

Experiment



GISSMO



5. Conclusion and discussion

- The fracture and instability curves are identified from the results of material tests evaluating the fracture. Then, the difference of failure criteria among several materials is discussed.
- Numerical fracture prediction of tensile test is performed accurately by using GISSMO.
- It is confirmed that the damage model GISSMO can be applied for various materials, namely high strength steel and aluminum alloy.