The relevance of Nb alloying in steels for future mobility requirements

CBMM
Niobium Nb

Is weight reduction still important?

Effect of weight reduction on CO_2 emission

Weight reduction of 100 kg results in:
-8 to -12 gr./km CO_2

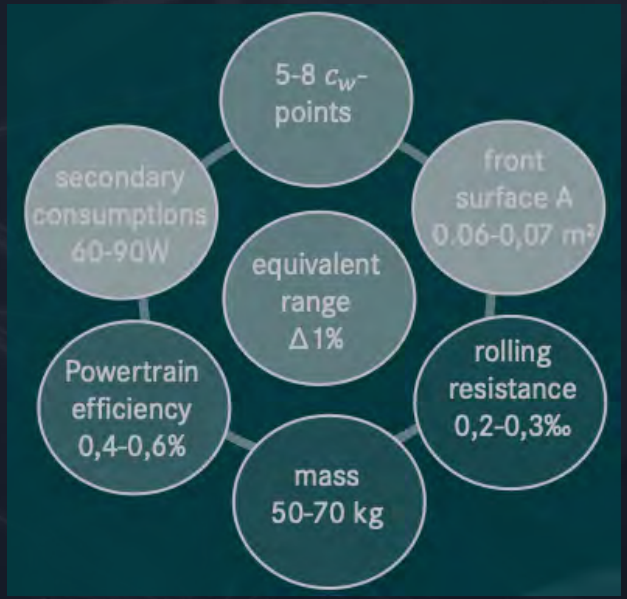
Effect of weight reduction on fuel economy

Weight reduction of 100 kg results in:
-0.15 to -0.5 liter/100 km fuel

Effect of weight reduction on driving performance

Faster acceleration, shorter braking distance, more payload

Range extension BEV



-100 kg weight = +8 km range

Is weight reduction still important?

BEV: up to 700 kg added

- Induces higher stresses on chassis and axle components.
- Increases kinetic energy and thus crash challenges.
- Causes more tire and brake wear (particle emission).
- Reduces drivability and handling.

⇒ Cost efficient weight reduction is still very relevant.

Component design considerations

Packaging requirements

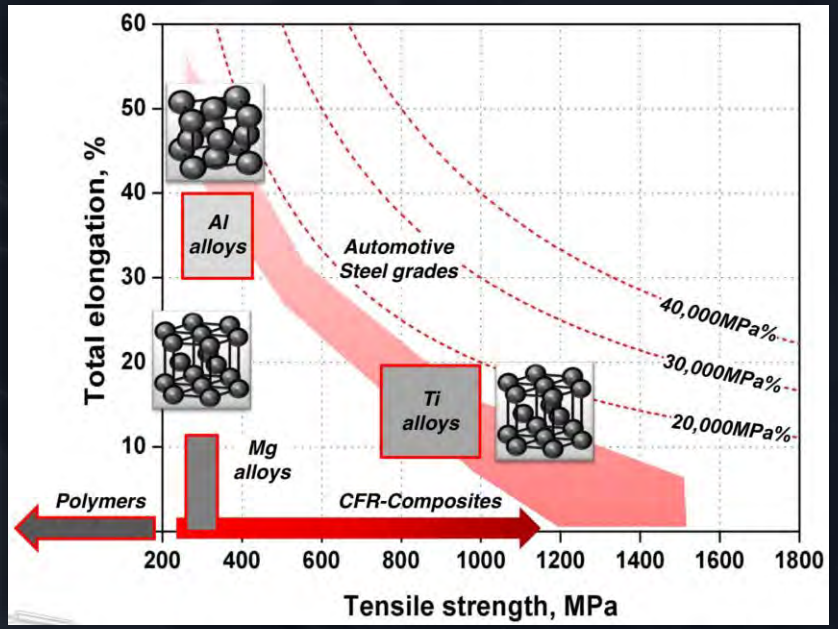
Conventional vehicles:

- Sophisticated component geometries.
- Complex deep-drawing operations.

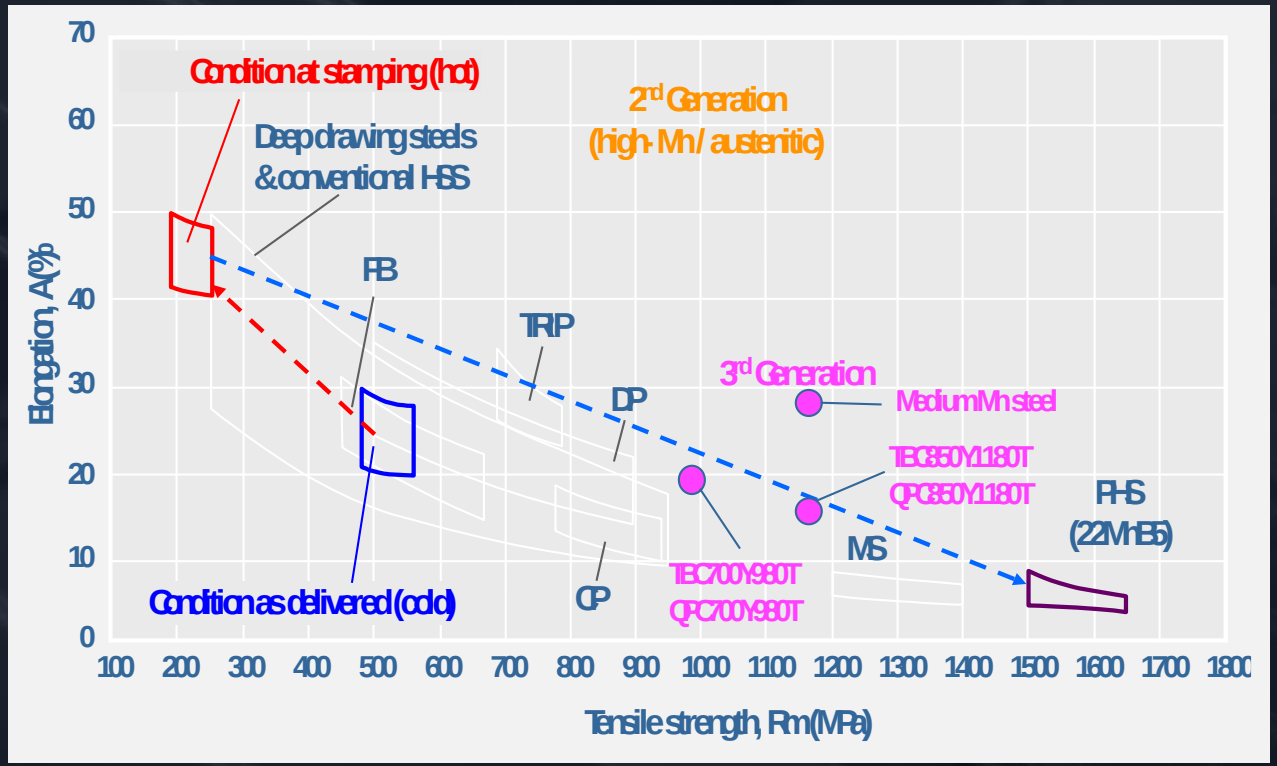
Electric vehicles:

- Less geometrically demanding deep-drawn parts, lower elongation demands.
- Packaging front end of pure electric vehicles is not particularly complex.
- Manufacturing by bending operations / roll forming.

Material choices

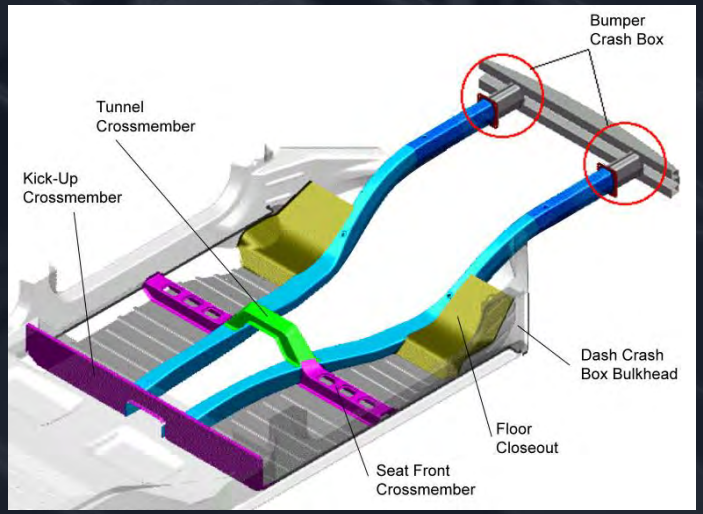


Choices of steel grades for car body components



Design requirements for construction materials

Simplified front-end structure



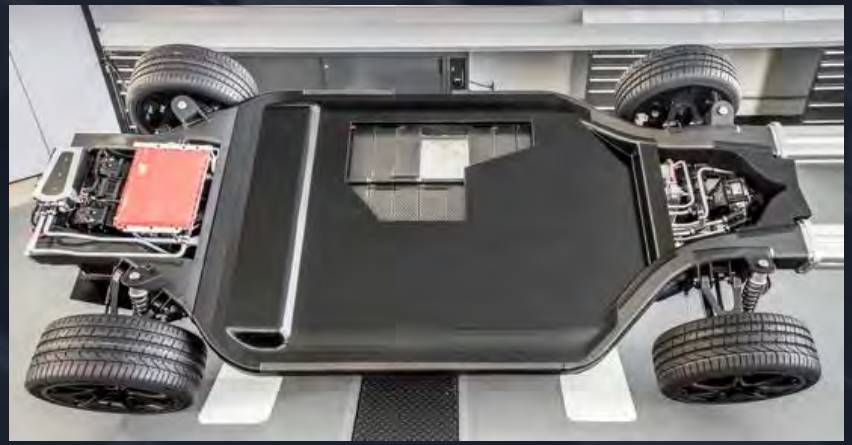
Missing engine block requires stronger front structure
⇒ Heavy gage PHS

Rather simple & straight geometries
⇒ Roll formed UHSS
⇒ Tubular structures

Strong & undeformable battery case
⇒ PHS or roll formed UHSS

No more tank – Integration of new energy storage

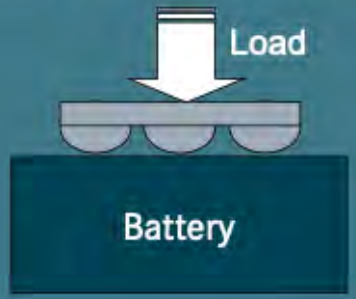
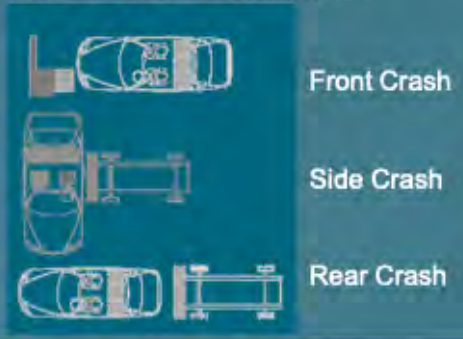
Battery skateboard



Hydrogen storage / fuel cell

Requires high protection against damage in case of crash.

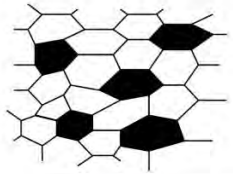
Mechanical integrity testing of new energy storage

Validity	Component approval	Vehicle approval only
Verification Test	Battery System-Level Evaluation 	Vehicle-Level Evaluation 
Requirements	No rupture ob battery enclosure -Finger proof- No electrolyte leakage out of battery housing No venting, No fire	

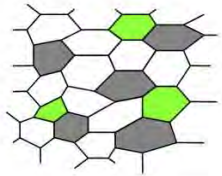
Evolution of ultra-high strength cold forming grades

1st gen. AHSS grades

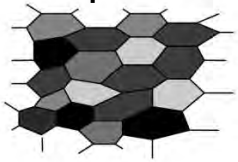
Dual Phase



TRIP

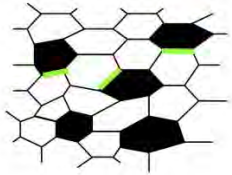


Complex Phase



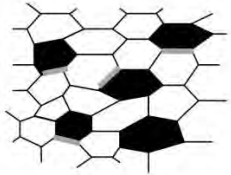
Advanced DP steel grades

Dual Phase HD



- Harder martensite
- Austenite as third phase

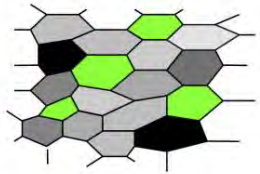
Low-C Dual Phase



- Softer martensite
- Bainite as third phase

3rd gen. steel grades

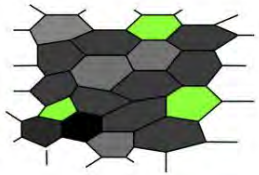
TRIP-Bainite



Dual Phase character:

- Lower strength & HER
- Higher elongation

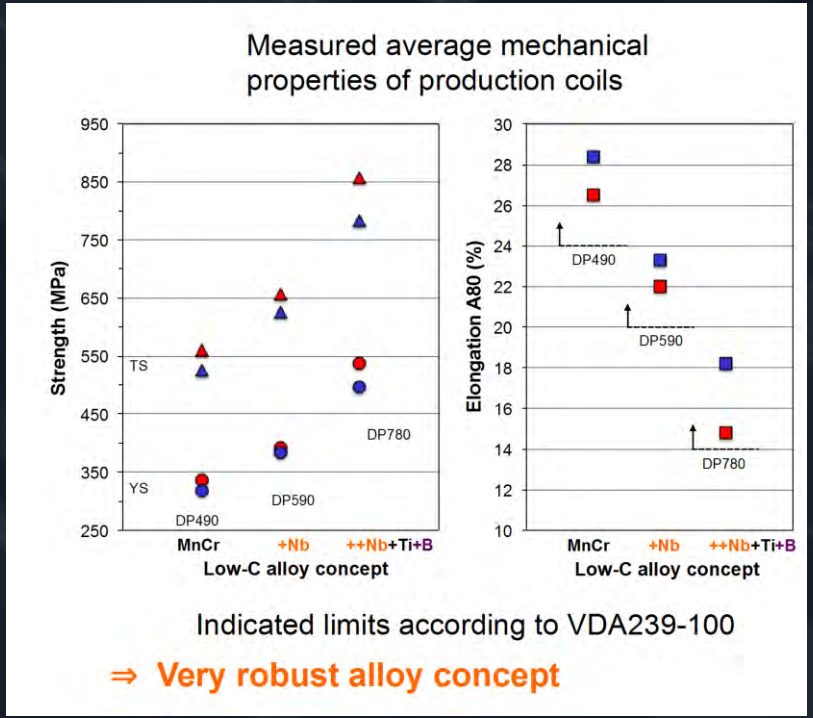
TRIP-Martensite

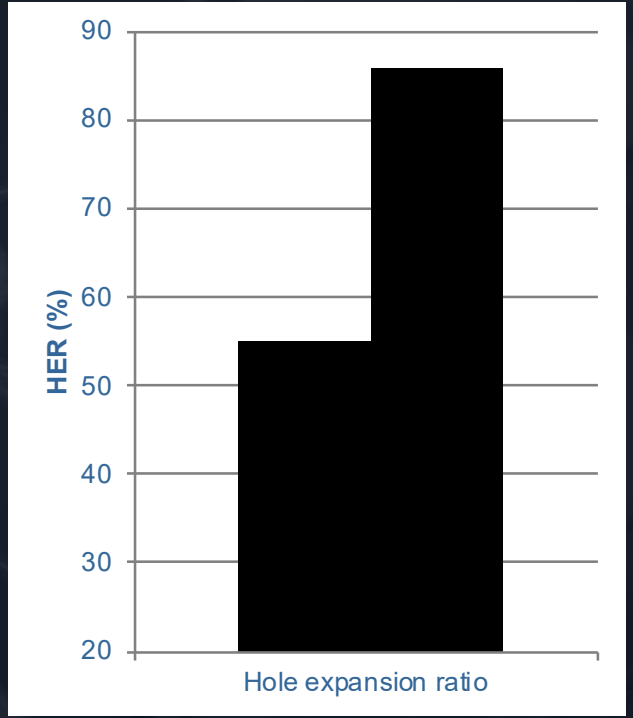


Complex Phase character:

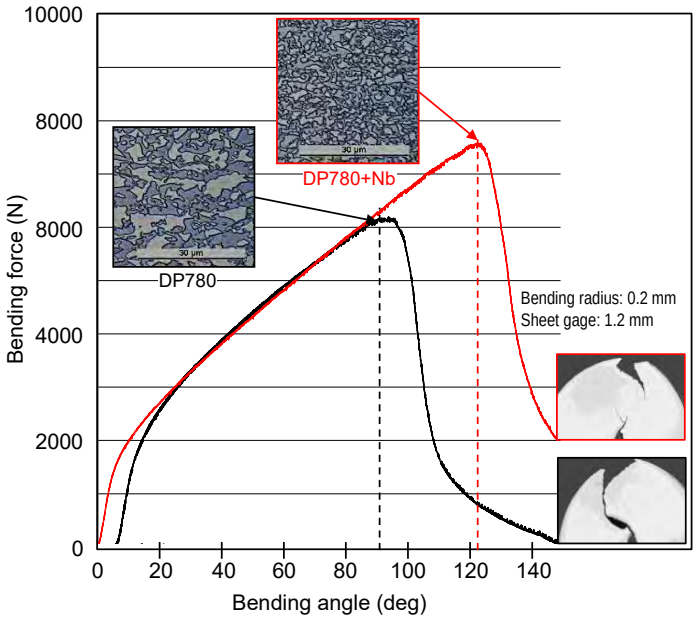
- Higher strength & HER
- Lower elongation

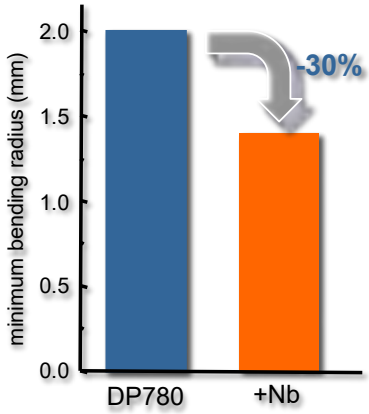
Low-C platform concept with Nb / B (Ti) microalloying





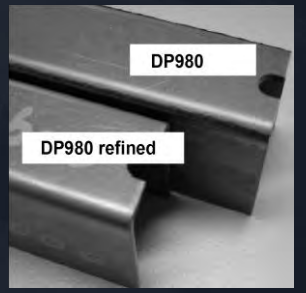
Improving bendability of DP grades by grain refinement

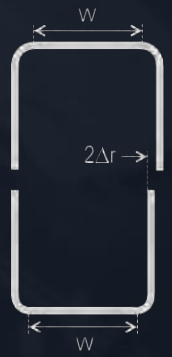




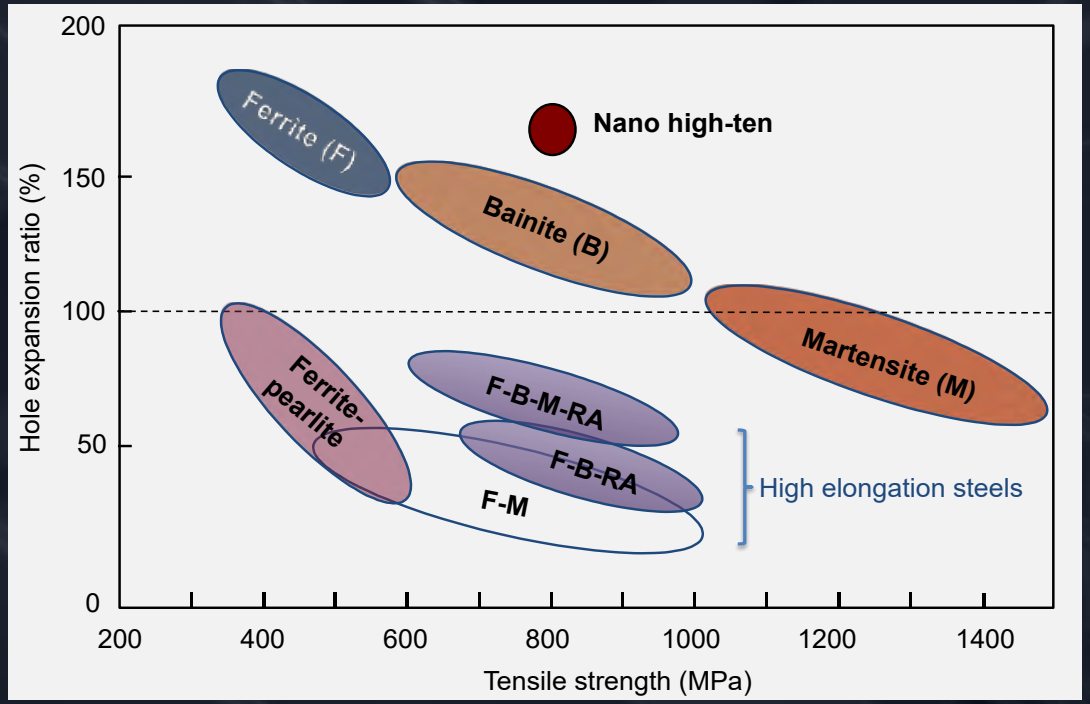
Nb-microalloying to standard DP780 steel refines microstructure:

- increased critical bending angle
- Reduced min. bending radius.





Profiling? – Single phase beats multiphase

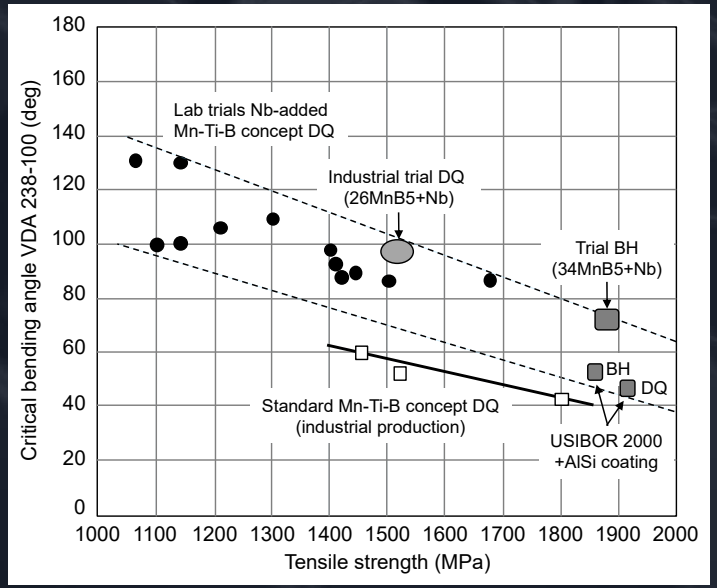


Profiling, bending, flanging

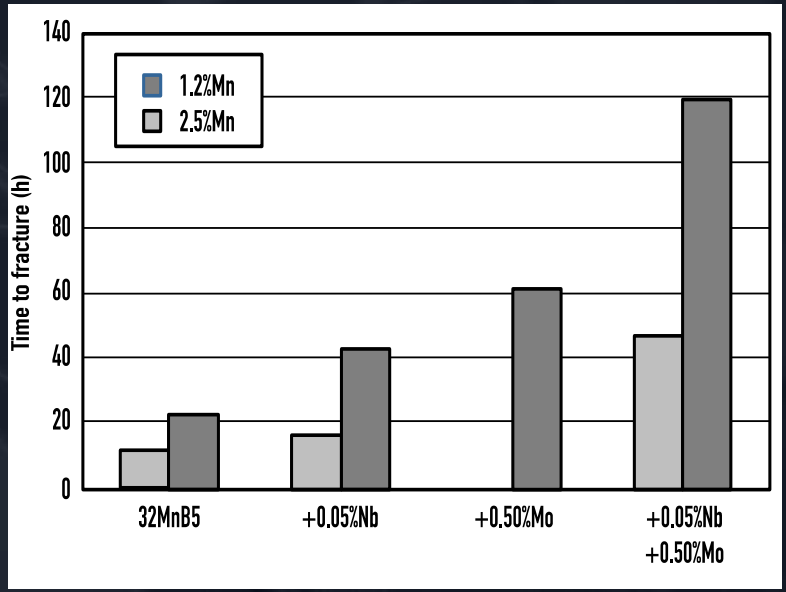
Drawing, stretching

Optimizing press hardening steel

Cracking resistance under bending



Hydrogen-induced cracking resistance



Niobium’s relevance in high strength steel grades

Drawing grades

- Multi-phase microstructure
- Grain refinement
- Homogeneous dispersion of phases
- Anti-delayed cracking

Bending grades

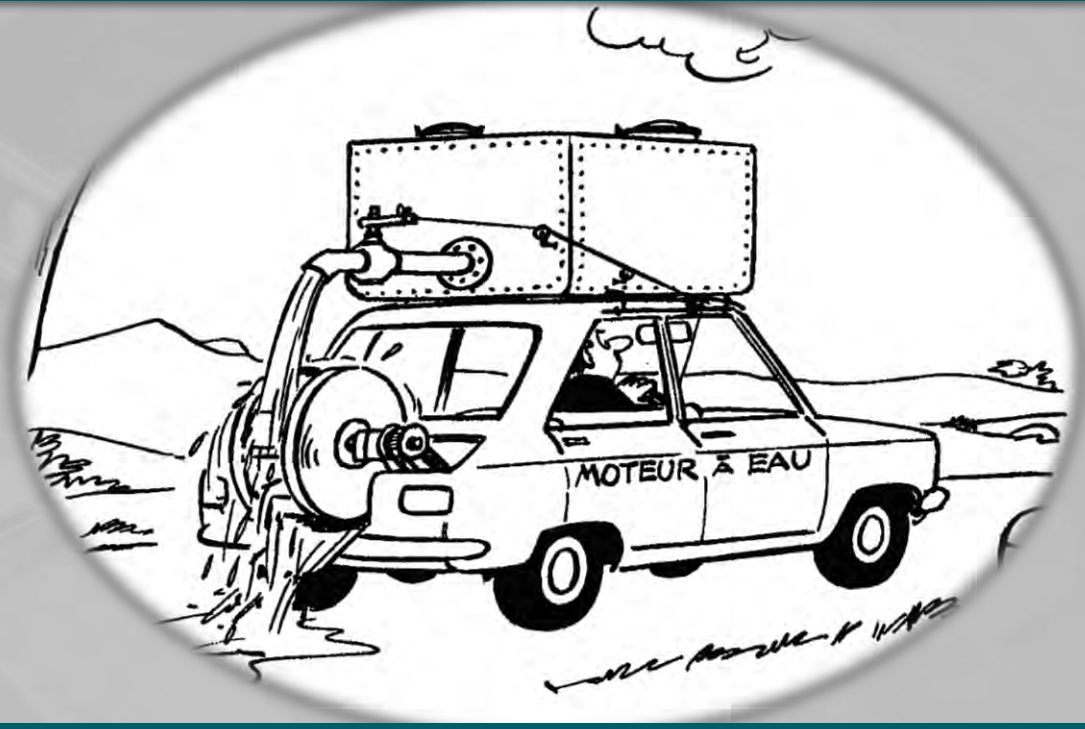
- Single-phase microstructure
- Grain refinement
- Precipitation strengthening
- Anti-delayed cracking

Balanced grades

- Compromise between elongation and hole expansion ratio

CONCLUSIONS

Cars will not run on water…



…and High Strength Steels will remain the most sustainable material for automotive components !