United States Steel
Automotive Solutions to Light Weighting

Generation 3 Steels - A Guide to Applications of Gen3 AHSS

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“The day of the passenger car made primarily of iron and steel is on the wane” giving ground to aluminum, magnesium and plastics.
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1970s – Body-on-Frame
   Body-Frame-Integral

1980s – Uncoated
   Galvanized Rust Resistant

1990s – Mild Steel
   High Strength and Bake Hard Steel

2000s – Mild & High Strength
   GEN1 AHSS and PHS

Today – GEN3 Advanced High Strength Steels
What is Gen3?

- **Generation 1**
  - IF
  - IF-HS
  - Mild
  - ISO
  - BH
  - CMn
  - ISLA
  - DP, CP
  - MART

- **Generation 2**
  - L-IP
  - AUST. SS
  - TWIP

- **Generation 3 AHSS**

- **UTS x TE = 25000**

- **USS CR 1180 Gen 3 Target**
Data Needed to Turn Coils into Parts

- Microstructure Characterization
- Compatibility with paint system
- Gauge and width capability
- Mechanical Properties
- Bake hardening / Aging
- Fatigue
- Hole expansion ratio
- Safe

- True Minor Strain
- True Major Strain
- Plane Strain
- Forming Limit Curve
- FLD

- Spot Weld
- Dynamic Crush
- Dynamic Bending
- Hydrogen embrittlement
- Fracture toughness evaluation

- Introduction
- Gen3 Characterization
- Gen3 Guide
- Summary
Mechanical Properties – Formability and High Strength

66% Higher Strength

25% Shorter crush distance

980 Gen3 make 37% weight save and better crush performance possible
5% Higher formability with 980 Gen3

Uniform strain distribution with 980 Gen3

980 Gen3 has 5% higher formability and better strain distribution than DP590
Welding 980Gen3 steels can be achieved with a wide range of welding parameters and uniform hardness behavior.
Dynamic Crush – Critical for Energy Absorption

Part Testing

Structural Analysis

Part correlation

Test/Simulation correlation

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Guide to Applications of Gen3

Material Portfolio

Functional Objectives

Structural Components

Forming

Assembly

Impact

Global Formability

Local Formability

Crack Resistance

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Material Portfolio – Hance Diagram View

Circle diameter reflects relative yield strength.
Understand the Components Functional Objectives

- Form into complex shapes
- Minimize Intrusion
- Absorb Energy

Load beam reinforcements
- B Pillar reinforcements
- Roof rail inner reinforcements
- Front Roof Header & Bow roof
- Panel Body side sill reinforcements
- Reinforcement Front & Rear rails
- Reinforcement floor cross members
Result with USS solution:

- Safe forming with upgrade & downgage
- Good correlation between CAE and trial
- 13% weight reduction
- Minimal springback without any adjustment to production die
Result with USS solution:

- Safe Forming
- Improved crack resistance
Determination of minimum die radius

Critical R/t Values for 980G3 Materials

- 980G3 HY
  - Transverse: 3.17
  - Longitudinal: 4.67
- 980G3 EG
  - Transverse: 2.5
  - Longitudinal: 2.5
- 980G3 CR
  - Transverse: 3.96
  - Longitudinal: 3.96

Decreasing local formability

Future Paper
Local Formability - Crack Propagation & TFS

Graph showing the relationship between True Fracture Strain (TFS) and Average Crack Length (Bend Crash Test, mm) for different materials:

- PHS 1300
- GI DP 980-IBF (#1)
- GI DP 980-IBF (#2)
- GEN3 980
- DP 980
- TBF 980
- DP 980-HY

The graph indicates a decreasing trend in crack length as TFS increases.
Local Formability - Crack Propagation & TFS

![Graph showing relationship between Total Crack Length (Axial Crash Test) and True Fracture Strain (TFS).](image)

- **DP 980 (LSi)**
- **SHF 1180**
- **DP 980-IBF (GI)**
- **DP 980**
- **TBF 980**
- **GEN3 980**
- **DP 980-HY**

*Under Development*
Material Portfolio

Functional Objectives
- Form into complex shapes
- Minimize Intrusion
- Absorb Energy

Forming

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