# Sheet Metal Analysis

**Sheet metal** is widely used across various industries, making it crucial to understand its **forming behavior** and mechanical properties. The **Forming Limit Curve (FLC)** is a critical criterion used in **sheet metal forming** to predict the material's behavior under different strain conditions. It provides a **failure threshold** by mapping **major and minor strain** values, helping manufacturers optimize forming processes and prevent defects. The **Forming Limit Diagram (FLD)** represents the maximum formability of a material and is typically determined using the **Nakajima test**, a standardized test method for **evaluating forming limits**.

## Objective

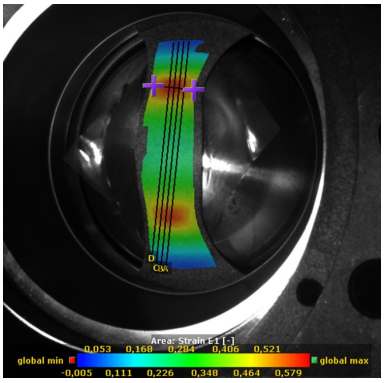
This case study aims to determine the **Forming Limit Curve (FLC)** and **Forming Limit Diagram (FLD)** for three sheet metal specimens using a **Nakajima test** and **3D Digital Image Correlation (DIC)**.

## Description of the Case Study

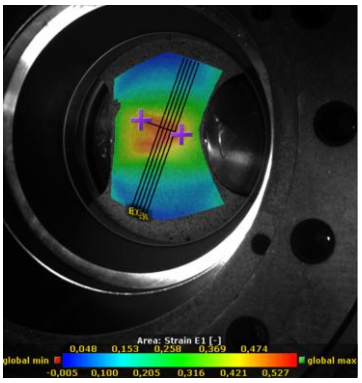
The experiment analyzed **three steel sheet metal specimens** with different geometries (30 mm, 60 mm, and 120 mm) using **a 3D DIC setup**. The testing setup included:

- **Cameras:** Two **synchronized Basler 2.3 MP cameras**
- **Frame Rate: 50 fps**
- **Camera Position:** Angled at approximately **15°** for capturing **out-of-plane motion**
- **Measurement Process:** Full-field strain and displacement tracking using **stereo DIC**

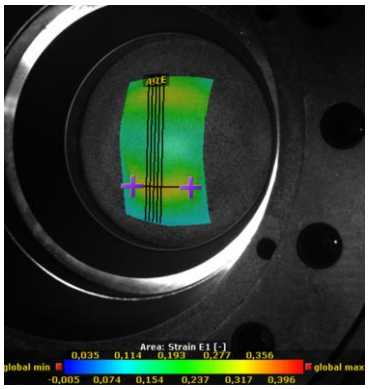
This setup enabled **high-precision tracking** of surface deformation in all three axes (**x, y, z**) during the Nakajima test, providing valuable insights into the material's **mechanical response**.




*DIC: Displacement in X [mm]*




*Sheet Metal 60mm*




*Sheet Metal 120mm*

MERCURY RT

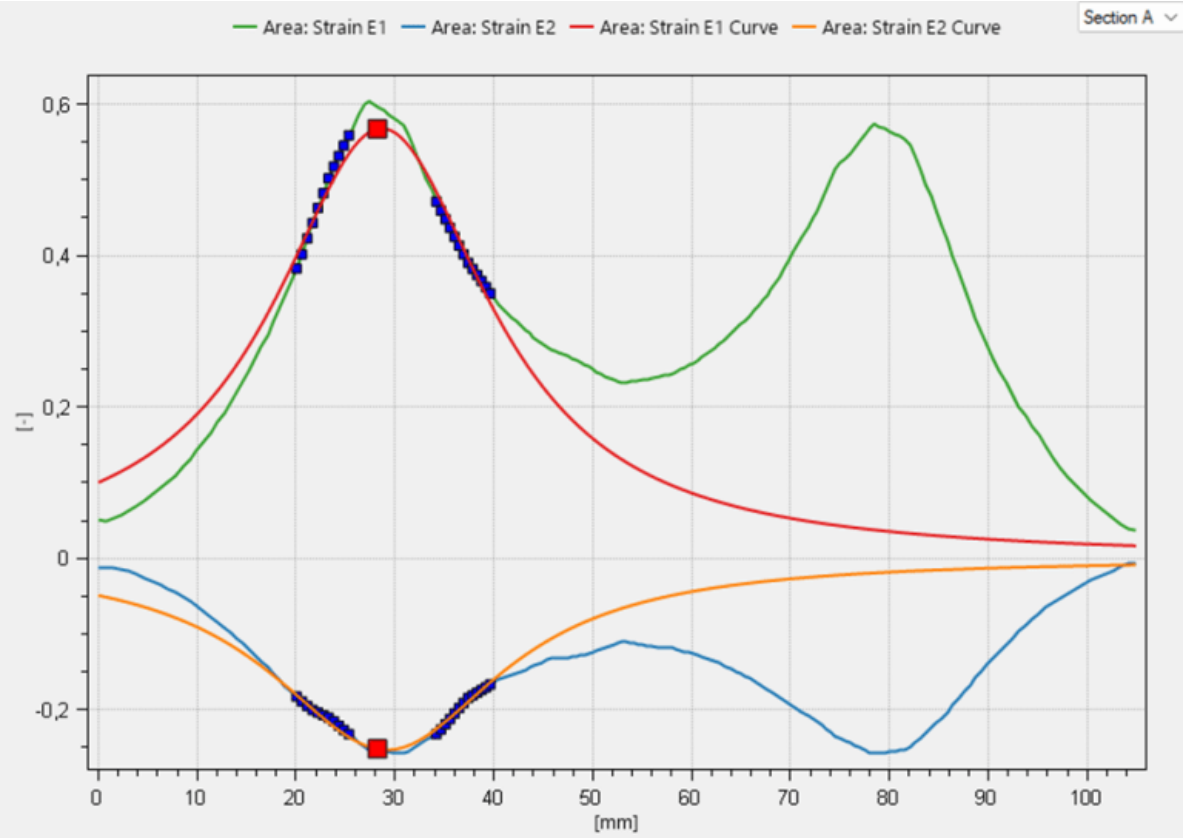
# Key Results

### ❖ Strain Distribution and Crack Analysis

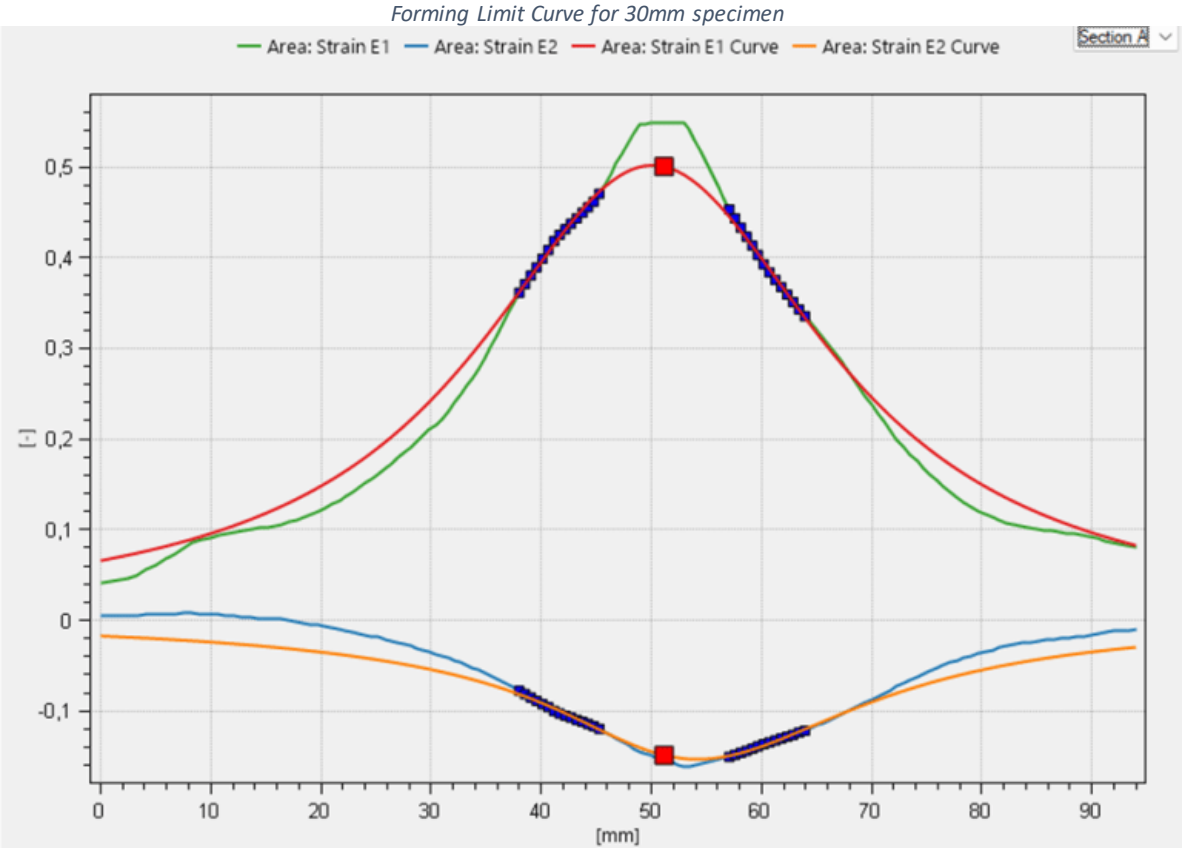
The strain distribution was measured for **three specimen geometries (30 mm, 60 mm, 120 mm)**. The images below show the **input crack line settings** for different specimens, allowing for accurate evaluation of **failure locations**.

### ❖ Forming Limit Curve Evaluation

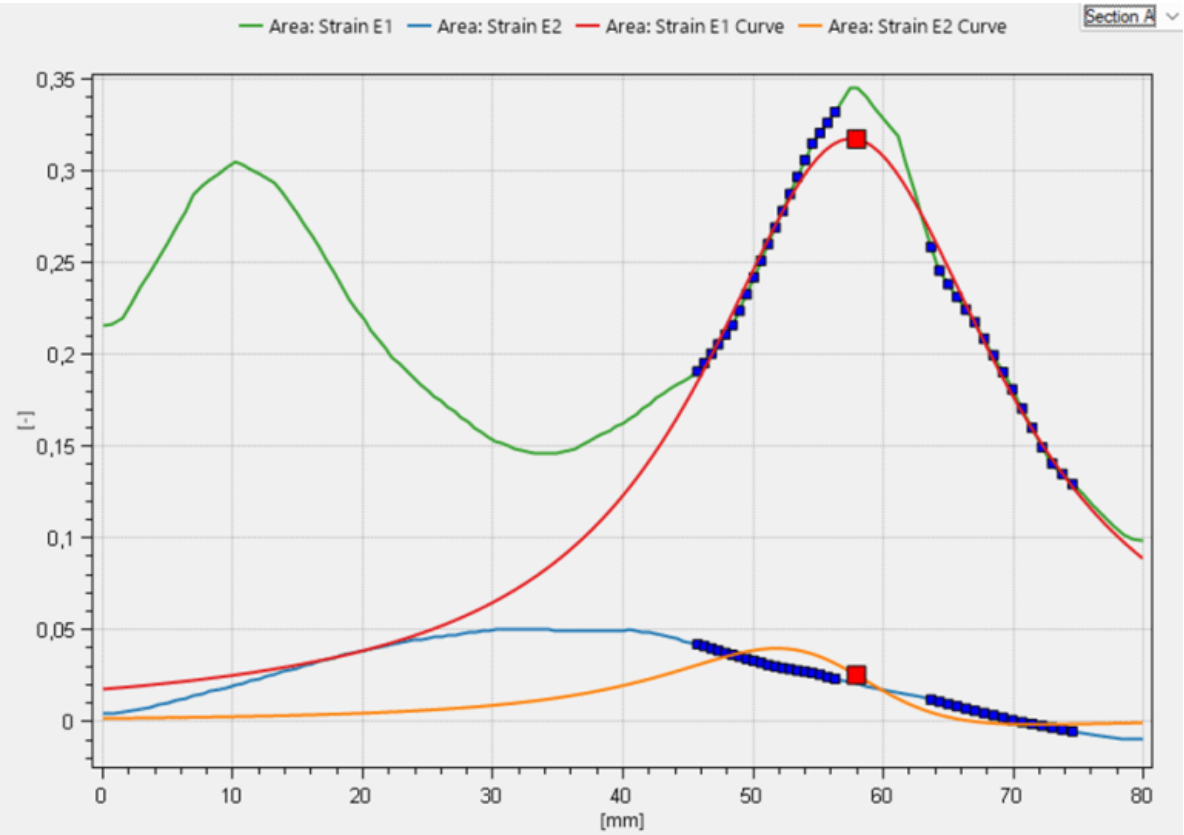
The strain distribution was measured for **three specimen geometries (30 mm, 60 mm, 120 mm)**. The images below show the **input crack line settings** for different specimens, allowing for accurate evaluation of **failure locations**.




*Forming Limit Curve for 30mm specimen*

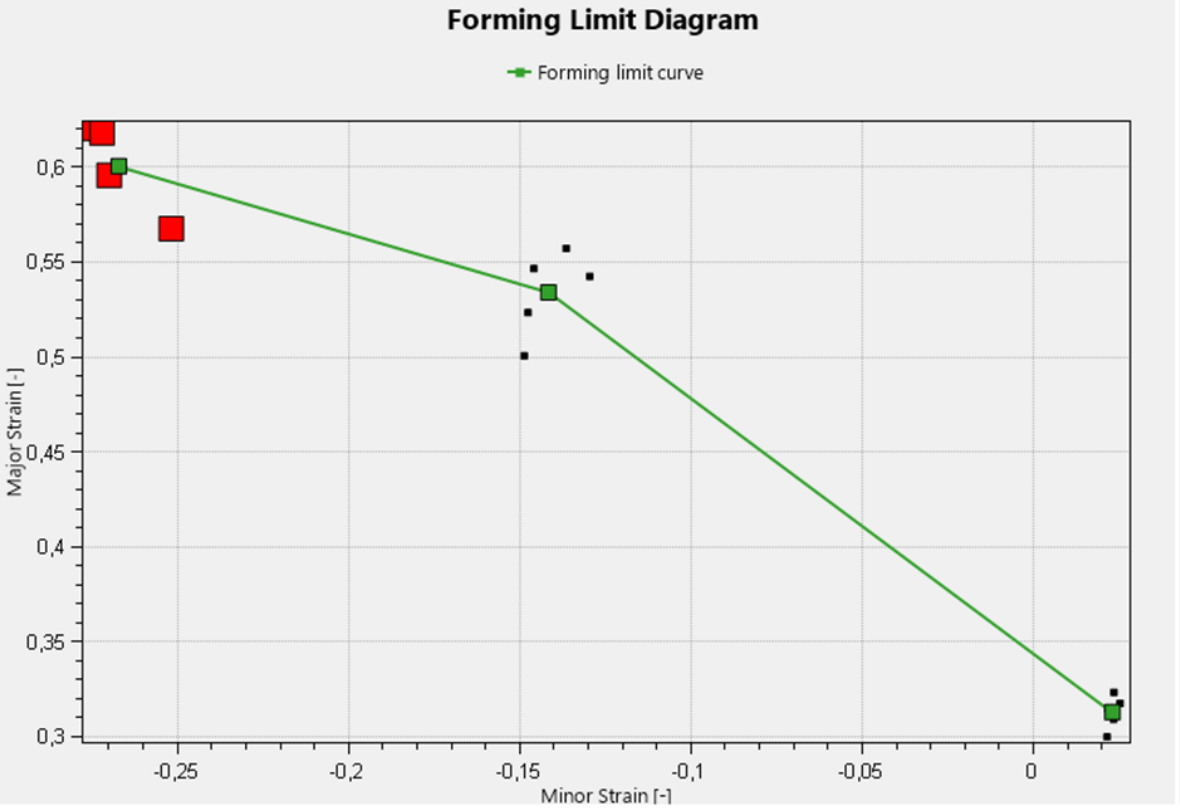



*Forming Limit Curve for 60mm specimen*




*Forming Limit Curve for 120mm specimen*

The final FLC analysis confirmed the **material's forming capabilities** and provided data for optimizing **manufacturing processes** to reduce failure risks.




*Forming limit diagram*

## Advantages of Using DIC for Component Testing

❖ **Full-field strain and displacement tracking** for high-precision analysis.

❖ **Non-contact measurement,** eliminates sensor interference with specimen deformation.

❖ **Real-time monitoring** of strain development and crack propagation.

❖ **Accurate out-of-plane motion capture**, essential for forming analysis.

❖ **Post-processing capabilities** for detailed analysis and FEA validation.