Temperature robust structure of a coordinate measuring machine

Agenda

1. Conceptual temperature stability
2. Simulation shopfloor temperature change
3. Temperature specification

Zeiss Industrial Metrology
Product portfolio

Systems

Performance Line

Production Line

Premium Line

Visual Line

Computer tomography

Large Bridge Line

From climate room to a shopfloor inline installation

Material mix

Combinations
- granite
- steel
- aluminium
- carbon fiber
- ceramic
- Invar
- polymer concrete
- glass
- Zerodur

The "right" combination and decoupling is important

Temperature stability

Environmental temperature change

Guideway stability at thermal gradients per hour, per day, per meter

all guideway changes are visible
“Swimming” zerodur scale

Minimized uncertainty for coefficient of thermal expansion $U_{CTE}$ and avoid temperature sensor uncertainty $U_t$.

Temperature robust structure

Thermal extension of the Z-shaft is compensated by the portal.

Temperature stability

Zero point drift.

Repeatable errors are correctable.

Temperature robust design

- polymer concrete base
- steel 3D-box
- steel linear guideway
- zerodur scale
- carbon fiber Z-shaft
- environment shroud

GageMax = flexible process gage

Temperature optimizing

Self-heating
- thermal drive decoupling
- motor exhauster
- motor insulation

Endurance stability

Temperature simulation

Environmental temperature change and thermal gradients.

Simulation of the thermodynamic behavior to increase development efficiency.
Temperature specification

- TVA MPEe \( \mu m = 1.2 + \frac{L}{(280-5 \times \Delta u)} \) (at a deviation of 20°C)
- allowed gradients
  - 2K/hour
  - 8K/day
  - 2K/meter
- Temperature range
  - 15 bis 40°C

TVA Temperature Variable Accuracy