Sheet Metal Development Centre

Provides research, product development, education and technology transfer services to Finnish sheet metal industry in order to improve the competitiveness of products and production. The focus areas are:

- **Coil coatings and long-term durability**
  - development of metallic and organic coil coatings
  - development of testing methods
  - corrosion and weathering testing
  - consulting related to long-term durability

- **Cold-formed thin-wall steel structures**
  - structural testing
  - analysis of load-bearing structures
  - consulting related to practical design work

- **Sheet metal forming and joining**
  - strain analysis (ARAMIS, ARGUS, ASAME)
  - formability testing (FLC, LDR, Erichssen test)
  - numerical analysis of forming processes
  - embrittlement, friction and springback tests
  - joining of sheet metal

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- competitiveness of products and production
- services to Finnish sheet metal industry in order to improve the competitiveness of products and production

Current research activities at HAMK Sheet Metal Development Centre

Content of presentation:
- research areas
- facilities and equipment
- current research projects
Optical systems for measurement and analysis of surface strains in formed sheet metal parts

- Measures and calculates the surface major strains, the directions of strains, the effective strain and thickness changes.

Determination of Forming Limit Curves (FLC)

- Formability of sheet metal can generally be illustrated using forming limit curves (FLC) diagrams, which are utilized when analyzing the manufacturability of sheet metal products.

- According to standard EN 12004-2:2008 with the Nakazima method, using formed cup-like test samples, forming limit diagrams are utilized when analyzing the manufacturability of sheet metal products.

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Formability, friction and springback testing

Formability tests
- Erichsen test
- Drawing limit ratio (DLR)
- Cup drawing test
- Hole expansion

Springback testing
- Bending under tension (BUT)

Embrittlement testing
- Secondary Working Embrittlement (SWE)
  - Interstitial-Free (IF) steels - temperature low to -80°C

The absence of solute interstitial elements in interstitial-free (IF) ultra-low carbon steel leads to sensitivity to SWE. The brittle fracture may occur at low temperature during secondary deformation such as during impact loading, progressive forming and trimming operation of drawn parts.

Hydrogen induced brittle fracture (HIB)
- AHSS for automotive applications

Hydrogen embrittlement is the process in which metal becomes brittle and fractures following exposure to hydrogen. HIB is often the result of unintentional introduction of hydrogen into susceptible metals during forming or finishing operations.

Weldability range (EN ISO 14327:2004)
- Testing related to resistance welding
- Evaluation of the lifetime of spot welding electrodes (EN ISO 8166)
- Wedge pull test (EN ISO 14379:2004)

Testing Related to Resistance Welding
- Formability, friction and springback testing
- Bendability range (EN ISO 14379:2004)
- Welding electrode (EN ISO 8166)
Weathering testing in laboratory

- Corrosion chambers (3 chambers)
  Provides laboratory simulation of natural corrosion. Specimens are exposed to a series of different functions (fog, dry, and humidity) in a repetitive cycle that reproduces cyclic outdoor conditions.

- UV-cabinets (3 cabinets)
  Ultraviolet light causes almost all the photodegradation to materials exposed outdoors. UV-tester reproduces only the UV portion of the spectrum. UVA-340 lamp is the best available simulation of short-wave sunlight. It is especially useful for comparing the performance of different types of polymers and stabilizers. All UV-cabinets have also moisture simulation. A QUV/spray can simulate the effects of rain, such as thermal shock and erosion.

- Condensation cabinets (3)
  Condensation cabinet applies controlled warm condensation to the test surface. In a QCT, wetness can be an invisible dew or a continuous, high-temperature running condensate. It can also be programmed for cyclic dry-off to relieve the osmotic pressure. The QCT accelerates moisture attack by increasing the condensation temperature. It is especially useful for conducting fast, yet realistic, blister tests.

- Climatic test chamber (1)
  The behavior of various materials in rapidly changing conditions can be studied with the climatic test chamber. The changes in the temperature and the humidity of the climatic chamber can be cycled according to test specifications. Temperature range is between -80°C and 100°C, and the relative humidity of air between 10% - 95%.

- Freezers (2) and aging ovens (2)
  In addition to climatic test chamber, cold tests can be performed in a deep chiller or in a freezer. In temperature cabinets materials can be aged in temperatures up to 250°C.

Outdoor Testing – SCAB

- 30 g/l NaCl solution to fasten the corrosion.
- Samples are sprayed twice a week with 5% NaCl solution to create the SCAB effect.

Corrosion resistance of zinc coated screws used in steel roofs are tested to find out if the screws are suitable for use. - corrosion resistance will be tested - screws are drilled to racks which simulate roofs with different slopes and materials. Outdoor tests are compared with the results obtained in the laboratory.

SCAB = Simulated Corrosive Atmospheric Breakdown

- UV-resistance of organic coatings and sealants will be tested. Good corrosion resistance can be achieved by a suitable combination of zinc coating and painting.

Current Research Activities Related to Metallic and Organic Coatings

- Two sided zinc coating: the influence of zinc coating thickness on the humidity resistance of backing coat of coil coatings
- The influence of pH on the corrosion of ZnMgAl coated steel
- Development of a scratch and abrasion tester
- Drying times of organic coatings and sealants
- Round robin testing between laboratories who make corrosion and weathering testing. The aim of the comparison tests is to improve the uniformity of test results between laboratories.

- Deformation of a scratch and abrasion tester
- The influence of pH on the corrosion of ZnMgAl coated steel
- Two sided zinc coating: the influence of zinc coating thickness on the humidity resistance of backing coat of coil coatings

Corrosion Resistance of Screws

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Cold-formed thin-walled steel structures

Experimental research and testing

Research of cold-formed steel structures

Recent projects

Structures

Testing of cold-formed steel structures

- Stiffness and resistance of load-bearing members and sheeting
  - Bending and shear resistance
  - Reaction resistance
  - Bearing resistance and sagging
  - Stiffness and resistance of load-bearing members

Loading Frame

- System is suitable for static and dynamic (fatigue) loadings
- Cylinders are of the latest technology used e.g. in the automotive industry
- Computer controlled: loading and displacement speed can be pre-programmed and adjusted based on the actual load
- Position of the cylinders can be changed continuously from vertical to horizontal
- In addition to the new system, the older system with multiple cylinders can still be used

Prototype testing:

- New materials, new products, new solutions
- Initial type evaluation tests (ITT)
- Product approval tests
- Research and development of new systems
- Composite construction members
- Research of cold-formed steel structures
- Experimental research and testing
- New materials, new products
The Zwick/Roell Z050 universal testing machine can be utilized in different research tasks:

- Testing of materials and fixtures

Some current assignments:
- Testing road-safety products – properties of bolts and rails
- Strength of fastening system TAK®
- Strength of rivets in an old Langer truss
- Determining the design values for glass fibre reinforced samples
- Bending strength of reinforced plastic honeycombs

FE-simulations
- In the development of cold-formed thin-walled structures
- Simulation of forming processes
- Non-linear analyses of structures

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