New Book

OPEN DIE FORGING TECHNOLOGY OF SPECIAL & ALLOYED STEELS WITH FAILURE ANALYSIS

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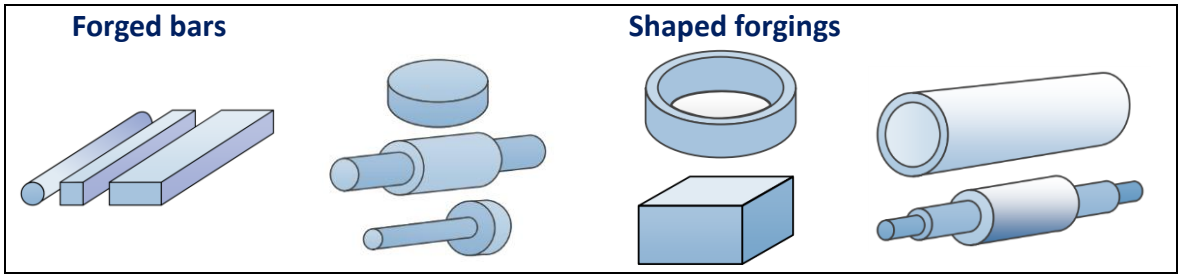
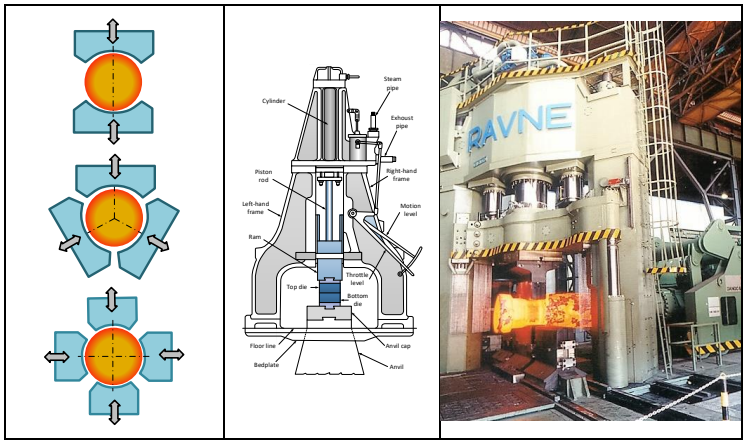
This book is a manual of Open Die Forging Technology and associated Failure Analysis, based on practical experience, and is intended for the preparation of operational technologies for various forgings (bars of round, square and flat sections, discs, blocks, shafts, spindles, rings, bushings, rolls, etc.) made of special and alloyed steels:



The volume of the book is over 200 pages and it covers the individual topics of Open Die Forging in details, which are necessary for the preparation of operational technology:

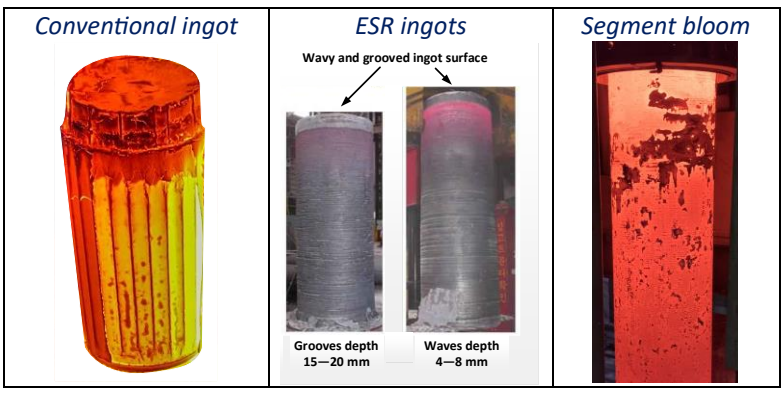
EQUIPMENT

- *Heating furnaces*
- *Open Die Forging Hammers*
- *Open Die Forging Presses*
- *Radial Forging Machines*
- *Equipment selections according to the forging program*
- *Determination of productivity*
- *Determination of forging, heating and heat treatment capacity*
- *Dies geometry*
- *Dies material and heat treatment*



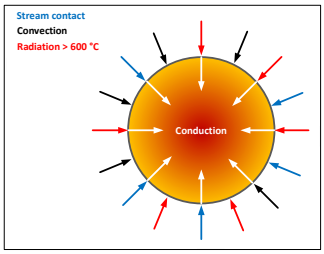
FORGING CHARGE

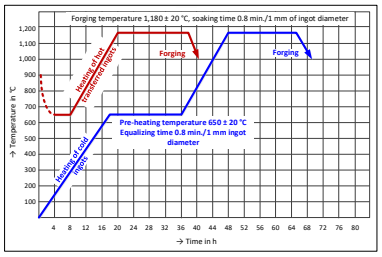
- *Conventional*
- *Remelting ingots*
- *Continuous casted blooms*
- *Segment casted blooms*
- *Casting & Stripping*
- *Treatment before heating*
- *Macro & Micro inclusion*
- *Macro & Micro segregation*
- *Discontinuities*
- *Surface roughness*
- *Grooved surface*



HEATING TECHNOLOGY

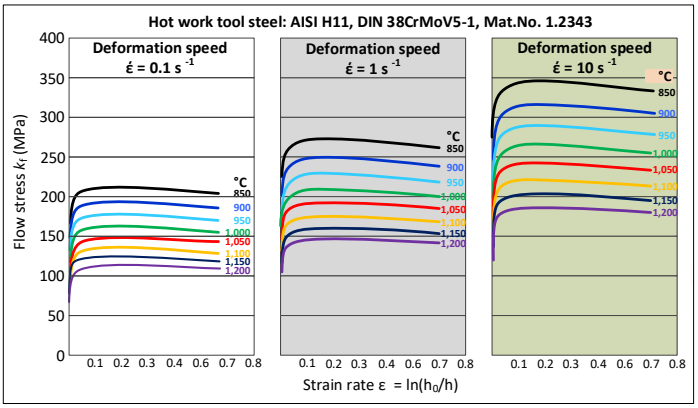
- *Ingot cooling*
- *Ingot transfer*
- *Ingot heating*
- *Thermal conductivity of the steels*
- *Heating rate*
- *Soaking time*
- *Heating time*
- *Homogenization*





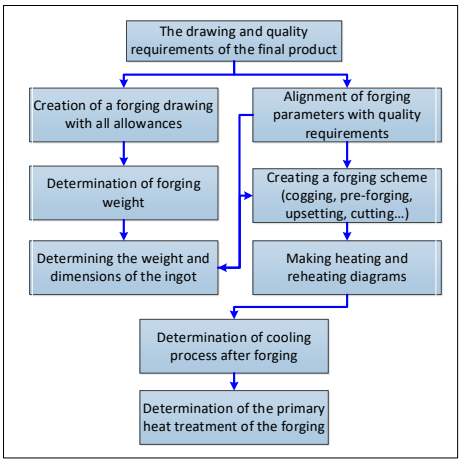
HOT WORKABILITY OF SPECIAL STEELS

- *The influence of chemical composition on the flow stress*
- *The influence of temperature on the flow stress*
- *The influence of deformation speed and deformation rate on the flow stress*
- *Determination of the plasticity of the steels*
- *Forging rate & Solid reduction*
- *Forgeability of the steels & alloys*



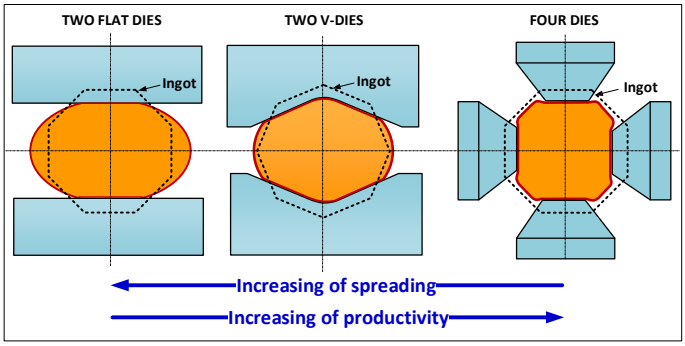
DESIGN OF FORGING TECHNOLOGY

- *Forging drawing:*
  - *Allowances for machining*
  - *Allowances for heat treatment*
- *Determination of forging weight*
- *Determination of Ingot weight*
- *Selection of ingots*
- *Adaption of forging parameters to the quality requirements of forging*
- *Heating & Reheating*
- *Cooling after forging*
- *Heat treatment after forging*
- *Forging procedure*
- *Quality assurance*
- *Product traceability*



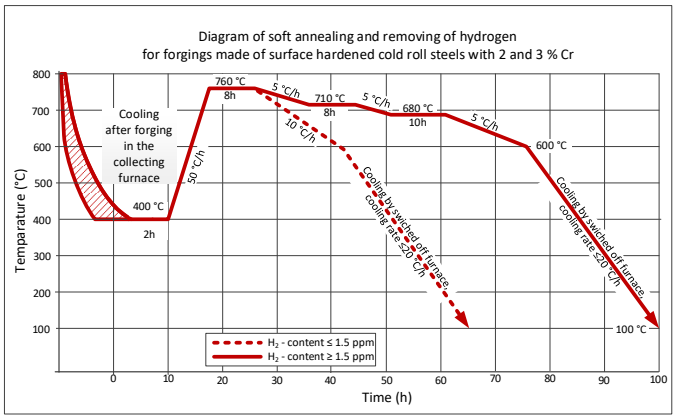
FORGING PRACTICE

- *Ingot cogging*
- *Pre-forging*
- *Forging*
- *Planishing*
- *Upsetting*
- *Punching*
- *Mandrel forging (rings, bushes)*
- *Forge cutting*
- *Material yield*
- *Guidelines for individual steels*
- *Dies selection*



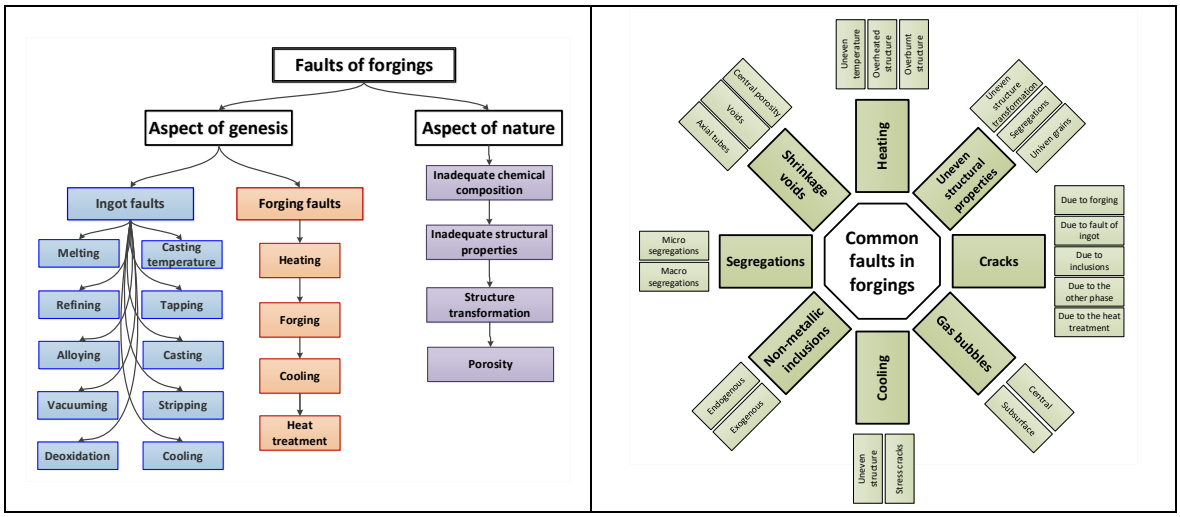
HEAT TREATMENT OF FORGINGS

- *Controlled cooling after forging (air, insulated pit, furnace, cooling to prevent precipitation of secondary carbides)*
- *Determination of cooling time*
- *Stress relieving annealing*
- *Soft annealing*
- *Spheroidize annealing*
- *Full annealing*
- *Normalizing*
- *Heat treatment of austenitic steels*
- *Hardening & Tempering*



FAILURE ANALYSIS OF FORGING

For each of the approximately 40 most common internal and surface faults, regardless of ingot, forging or heat treatment origin, the mechanism of its occurrence is explained on 72 pages and the measures to prevent, mitigate or eliminate it are indicated, all supported by photos, graphs and sketches.

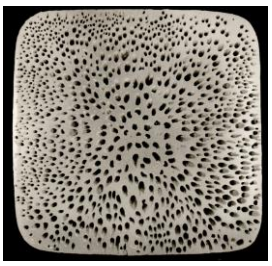


Examples of surface and internal defects:

Some ingot surface defects reflected in the forging

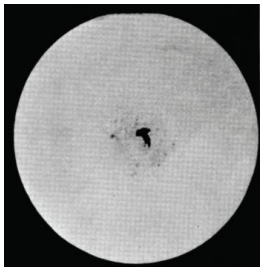
Some ingot internal defects reflected in the forging

Central macro porosity in a round ingot weighing 5 t

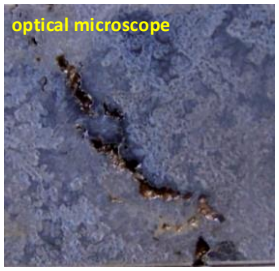


"Swiss cheese" or tubular voids between dendrites caused by excessive gas presence in ESR

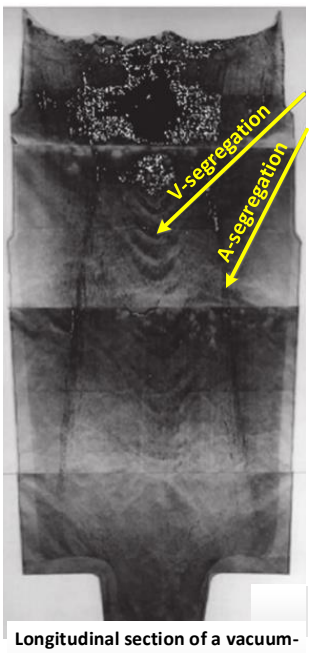
Macro inclusions of slag on the fracture of the ESR ingot, which cracked at the start of forging



The remainder of shrink hole due to insufficient feeding during solidification

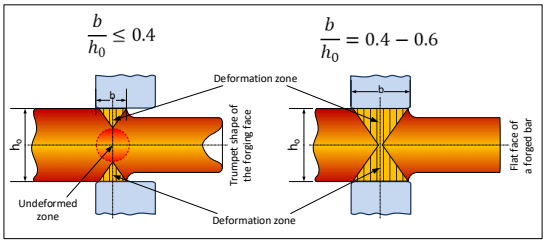


A non-metallic inclusion surrounded by carbides, sulfur precipitates and low-melting-point phases

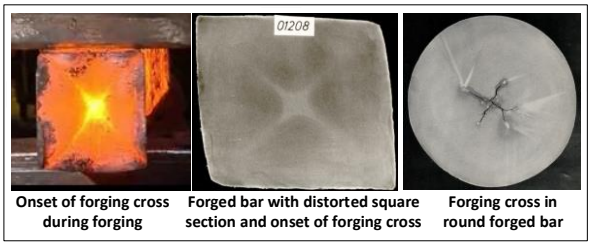


Longitudinal section of a vacuum-cast forging ingot with a macro structure, weighing 110 t

Fishtail formation

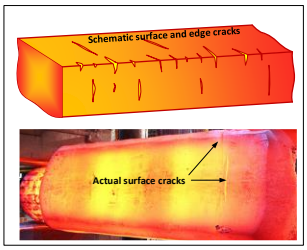


Forging cross formation

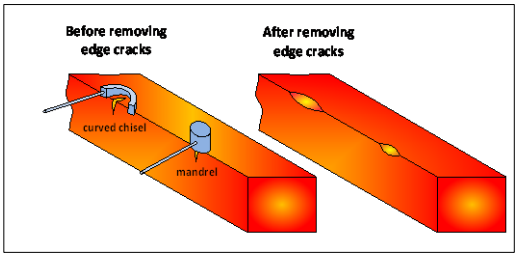


Onset of forging cross during forging | Forged bar with distorted square section and onset of forging cross | Forging cross in round forged bar

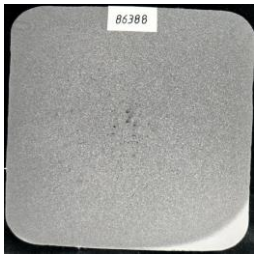
Forging surface cracks



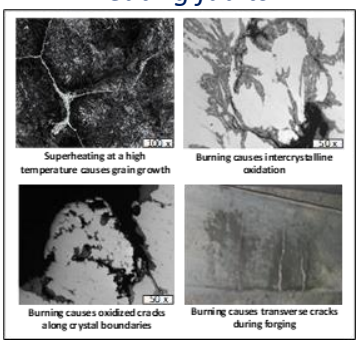
Removing of edge cracks



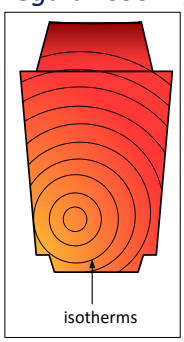
Central porosity



Heating faults



Irregular cooling



Forging central cracks