

Master examination

„Steel Design“

03.08.2017

Name, first name:

Matriculation number:

Declaration: I am healthy and able to take part in the examination.

Signature:

| Task | Points | Achieved points | Points after review (additional points) |
|------------|-----------|-----------------|--|
| 1 | 3 | | |
| 2 | 6 | | |
| 3 | 4 | | |
| 4 | 4 | | |
| 5 | 4 | | |
| 6 | 2 | | |
| 7 | 4 | | |
| 8 | 1 | | |
| 9 | 3 | | |
| 10 | 4 | | |
| 11 | 5 | | |
| 12 | 3 | | |
| 13 | 3 | | |
| 14 | 4 | | |
| | | | |
| Sum | 50 | | |

You need 44% to pass the examination.

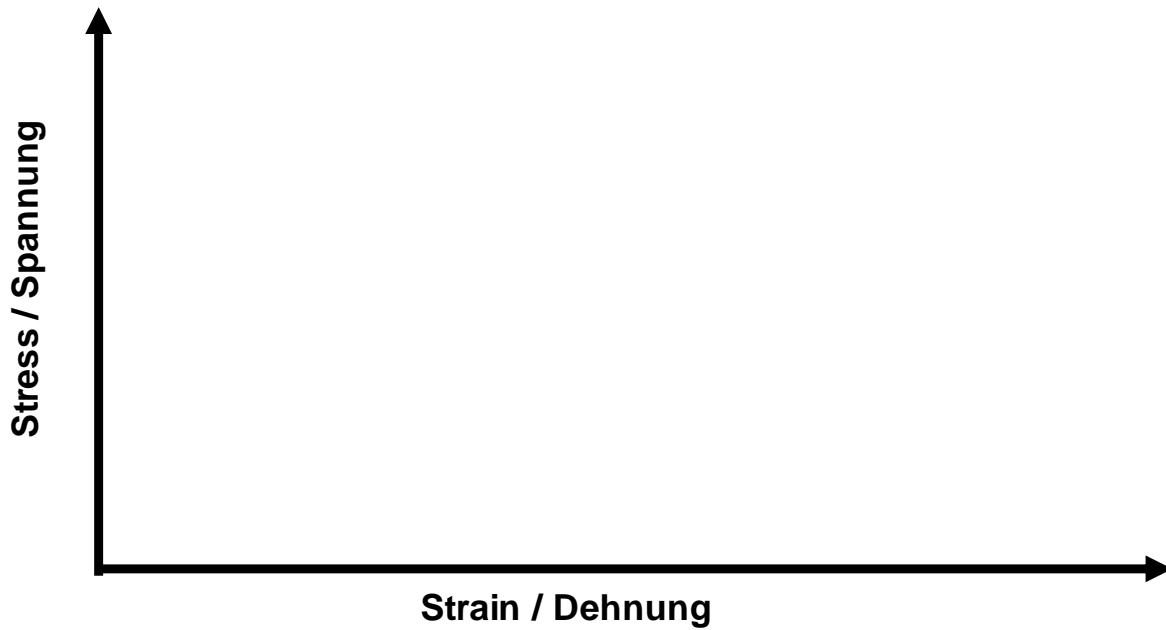
Task 1**AHSS I****3 Point(s)**

Using a light optical microscope, you compare three thin sheets: a mild steel, a DP-steel and a TRIP-steel.

Sketch the observed microstructure, paying attention to the different grain sizes! Which phases can be observed in the microstructure of the three steel types? Give the approximate volume fractions. (3 Points)

Task 2**AHSS II****6 Point(s)**

- a) Sketch the stress strain curves of the following steels in the given diagram (figure 1):
(i) a DP-Steel and (ii) HSLA-Steel (without temper rolling). Explain the individual material behavior of the steels. (4 Points)

**Figure 1**

b) What is the influence of the following factors on the ultimate tensile strength of DP-Steels? (1.5 Points)

- i) A larger martensite volume fraction
- ii) A larger ferrite grain size
- iii) A higher carbon content in martensite

c) Is there any influence of the martensite island diameter on the mechanical properties of DP-steels? Explain your answer briefly. (0.5 Points)

Task 3**AHSS III****4 Point(s)**

Dual phase steels typically have a structure with 5 to 30 Vol .-% martensite. Explain the upper and lower limits based on microstructure-property correlations. (4 Points)

Task 4**AHSS IV****4 Point(s)**

The special properties of TRIP-steels are related to the presence of retained austenite in the microstructure.

- a) How is it possible to have retained austenite stable in a 0.2 wt.-% C steel? Explain your answer briefly. (2 Points)
- b) Is the retained austenite thermodynamically and/or mechanically stable? (2 Points)

Task 6**deep drawing steel II****2 Point(s)**

Deep drawing steels are separated into two types. The microstructures for both types are shown in figure 1.

- a) Which type is visible in figure 1a), which in figure 1 b)? (1 Point)

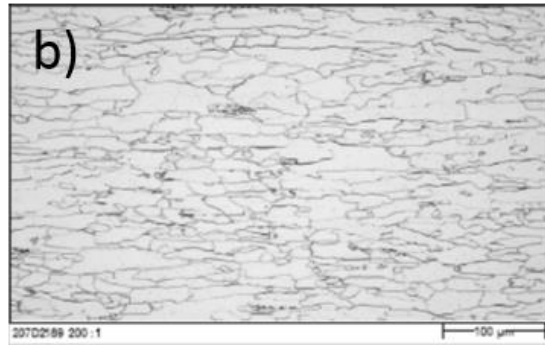
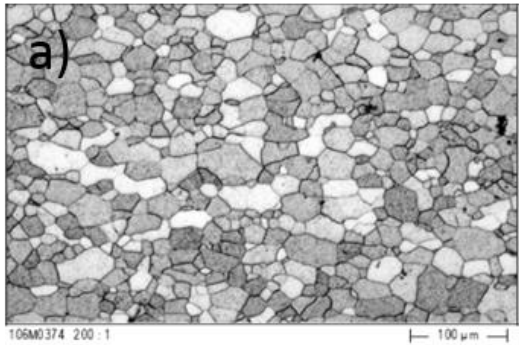


Figure 1: Micrographs of microstructure of two deepdrawing steels

- b) Describe briefly the characteristics of both microstructures. (1 Point)

Task 7 **pipe manufacturing I** **4 Point(s)**

- a) What is the name of the first basic processing step used in the production of seamless tubes broadly? (1 Point)
- b) Name three typical processing unit or techniques, which are used in the following process step (stretch forming). (3 Points)

Task 8**pipe manufacturing II****1 Point(s)**

What is the most commonly used welding process for welded pipe without using welding filler material? (1 Point)

Task 9 **Oil Country Tubular Goods (OCTG)** **3 Point(s)**

What is the most important aspect in improving the corrosion resistance to sour gas in high strength quenched and tempered steels for oil pipes from materials science point of view? (3 Points)

Task 10**precision tubes****4 Point(s)**

- a) What is the purpose of an “Autofrettage” treatment and how does this treatment affect the microstructure of the steel? (2 Points)
- b) For which components is the “Autofrettage” treatment necessary? Explain your answer briefly (2 Points)

Task 11**line pipes****5 Point(s)**

- a) Name two media, which are typically transported with line pipes? (1 Point)
- b) What are the requirements of the application areas on line pipes? Name at least two environmental conditions and explain the resulting requirements for the material. (2 Points)
- c) What is the problem with media with an increased H₂S content? Explain the relevant chemical components and name the damage mechanisms. (2 Points)

Task 12**special alloyed steels****3 Point(s)**

Stainless steels can be separated into different groups based on their microstructure. Complete **table 1** with the microstructures of the stainless steels. (3 Points)

Table 1

| Microstructure | C | Cr | Mo | Ni | Cu | N | other |
|----------------|----------------|----------------|--------------|---------------|--------------|----------------|--------------------|
| | 0,01 – 0,03 | 16,5 – 21,0 | 0,1 – 5,0 | 8,0 – 26,0 | 0 – 2,0 | 0,02 – 0,25 | Ti/Nb: 5/10 x C |
| | 0,01 – 0,05 | 21,0 – 28,0 | 0,1 – 5,0 | 4,5 – 8,0 | 0,1 – 3,5 | 0,05 – 0,30 | W: 0 – 1,0 |
| | 0,06 - 1,10 | 12,0 – 17,0 | 0,1 – 2,0 | 0 – 2,5 | - | - | - |

Task 13**rail steels****3 Point(s)**

- a) The mechanical properties of some rail steels are improved with head-hardening. How does this treatment affect the final microstructure ? (1 Point)
- b) Talking about rails, there are two factors that determine the service lifetime, according to the field of application. Name both factors and explain what leads to their occurrence. Give an example for the fields of application they are used for. (2 Points)

